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Hermanson et al.

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(45) **Date of Patent: Feb. 2, 2016**

(54) **BENZOCYANINE COMPOUNDS**

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Related U.S. Application Data

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(51) **Int. Cl.**

G01N 33/533	(2006.01)
A61K 49/00	(2006.01)
C09B 23/08	(2006.01)

(52) **U.S. Cl.**

CPC ***C09B 23/083*** (2013.01); ***A61K 49/0034*** (2013.01); ***A61K 49/0058*** (2013.01)

(58) **Field of Classification Search**

CPC A61K 49/0058; A61K 49/0034; C09B 23/083

See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

1,524,791	A	2/1925	Konig
4,839,265	A	6/1989	Ohno et al.
4,981,977	A	1/1991	Southwick et al.
5,268,486	A	12/1993	Waggoner et al.
5,486,616	A	1/1996	Waggoner et al.
5,556,959	A	9/1996	Brush et al.
5,569,587	A	10/1996	Waggoner
5,569,766	A	10/1996	Waggoner et al.
5,627,027	A	5/1997	Waggoner
5,846,737	A	12/1998	Kang
5,972,838	A	10/1999	Pearce et al.
5,986,086	A	11/1999	Brush et al.
6,048,982	A	4/2000	Waggoner
6,083,485	A	7/2000	Licha et al.
6,136,612	A	10/2000	Della Ciana et al.
6,225,050	B1	5/2001	Waggoner
6,258,340	B1	7/2001	Licha et al.
6,342,326	B1	1/2002	Milton
6,534,041	B1	3/2003	Licha et al.
6,641,093	B2	11/2003	Coudrais
6,939,532	B2	9/2005	Achilefu et al.
6,974,873	B2	12/2005	Leung et al.
6,977,305	B2	12/2005	Leung et al.
7,172,907	B2	2/2007	Chen et al.
7,566,790	B2	7/2009	Leung et al.
7,671,214	B2	3/2010	Leung et al.
7,745,640	B2	6/2010	Czerney et al.
7,750,163	B2	7/2010	West et al.
7,790,893	B2	9/2010	Leung et al.
7,820,824	B2	10/2010	Leung et al.
7,855,293	B2	12/2010	Haalck et al.
7,927,830	B2	4/2011	Cheung et al.
7,951,959	B2	5/2011	Brush et al.
8,431,111	B2	4/2013	Nairne et al.
2001/0055567	A1	12/2001	Licha et al.
2002/0064794	A1	5/2002	Leung et al.
2002/0077487	A1	6/2002	Leung et al.
2004/0241095	A1	12/2004	Achilefu et al.
2006/0004188	A1	1/2006	Leung et al.
2006/0099638	A1	5/2006	Leung et al.
2007/0128659	A1	6/2007	Czerney et al.
2007/0178512	A1	8/2007	Leung et al.
2007/0203343	A1	8/2007	West et al.
2008/0233050	A1	9/2008	Achilefu et al.
2009/0035809	A1	2/2009	Leung et al.
2009/0305410	A1*	12/2009	Mao et al. 435/375
2010/0040547	A1	2/2010	Frangioni
2010/0196282	A1	8/2010	Nairne et al.
2010/0215585	A1	8/2010	Frangioni

(Continued)

FOREIGN PATENT DOCUMENTS

AU	2006200511	2/2006
DE	4445065 A1	6/1996

(Continued)

OTHER PUBLICATIONS

International Search Report and Written Opinion PCT/US2013/028252, issued by the European Patent Office, and mailed Apr. 25, 2013 (12 pages).

International Preliminary Report on Patentability, PCT/US/2011/065975, mailed Jul. 4, 2013 (8 pages).

International Search Report and Written Opinion for PCT/US2011/065975, mailed Mar. 15, 2012 (12 pages).

Examination Report, Great Britain Application No. 1214580.1, mailed May 31, 2013 (4 pages).

Hermanson, Bioconjugate Techniques, 2nd Ed., London, Elsevier Inc. 2008, pp. 464-474; 690-697.

(Continued)

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(74) *Attorney, Agent, or Firm* — Thompson Hine LLP

(57) **ABSTRACT**

Compounds useful as labels with properties comparable to known fluorescent compounds. The compounds are conjugated to proteins and nucleic acids for biological imaging and analysis. Synthesis of the compounds, formation and use of the conjugated compounds, and specific non-limiting examples of each are provided.

6 Claims, 16 Drawing Sheets
(9 of 16 Drawing Sheet(s) Filed in Color)

(56) **References Cited**

U.S. PATENT DOCUMENTS

2010/0267937	A1	10/2010	West et al.	
2010/0303732	A1	12/2010	Bahner	
2011/0065896	A1	3/2011	Licha et al.	
2011/0171678	A1	7/2011	Leung et al.	
2011/0178397	A1	7/2011	Bahner	
2012/0114563	A1	5/2012	Carter et al.	
2013/0230465	A1*	9/2013	Hermanson et al.	424/9.6
2014/0106349	A1	4/2014	Mao et al.	

FOREIGN PATENT DOCUMENTS

DE	19717904	A1	10/1998
DE	19926460	A1	12/1999
DE	10046215	A1	4/2002
EP	1152008		7/2001
EP	1181940		2/2002
EP	1322710		7/2003
EP	1770129		4/2007
EP	1792949		6/2007
EP	1801165		6/2007
EP	2325263		7/2010
GB	434875		9/1935
JP	03217837		9/1991
JP	Hei 5-313304		11/1993
WO	96/17628		6/1996
WO	98/48838		11/1998
WO	00/75237		12/2000
WO	02/26891		4/2002
WO	02/32466	A1	4/2002
WO	2004/065491		8/2004
WO	2004/065491	A1	8/2004
WO	WO 2004065491	A1 *	8/2004
WO	2005/044923		5/2005
WO	2005/103162		11/2005
WO	2006/020947		2/2006
WO	2009/016180		2/2009
WO	2009/016181		2/2009
WO	2009/078970		6/2009
WO	2009/078970	A1	6/2009
WO	2010/091126		8/2010
WO	2010/106169		9/2010
WO	2012/088007	A1	6/2012
WO	2012/129128	A1	9/2012

OTHER PUBLICATIONS

Strekowski (ed.), Heterocyclic Polymethine Dyes: Synthesis, Properties and Applications, (2008) Springer-Verlag, Berlin Heidelberg, pp. 1-241.

United Kingdom Search and Examination Report GB1214580.1, dated Nov. 22, 2012, 4 pages.

Wilchek, M. and Miron, T. Activation of Sepharose with N,N'-disuccinimidyl carbonate. Applied Biochemistry and Biotechnology, vol. 11, pp. 191-193 (1985).

Search Report issued by the German Patent Office regarding App #10 2006 029 454.8 issued Oct. 10, 2006 (with English language summary).

Search Report issued by the German Patent Office regarding App #10 2006 057 345.5 issued May 21, 2007 (with English language summary).

Alvarez-Maubecin, V. et al. Functional Coupling Between Neurons and Glia. The Journal of Neuroscience. Jun. 1, 2000, 20(11):4091-4098.

Bharaj, B.S. et al. Rapid sequencing of the *p53* gene with a new automated DNA sequencer. Clinical Chemistry. 44:7 1397-1403 1998.

Biotium. Product brochure titled CF™ Dyes The next-generation dyes for protein labeling. Apr. 6, 2009.

Burns, M.A. et al. An Integrated Nanoliter DNA Analysis Device. Science. vol. 282, pp. 484-487, Oct. 16, 1998.

DeRisi, J.L. et al. Exploring the Metabolic and Genetic Control of Gene Expression on a Genomic Scale. Science. vol. 278, ppl. 680-686, Oct. 24, 1997.

Fradelizi, J. et al. Quantitative Measurement of Proteins by Western Blotting with Cy5™ -Coupled Secondary Antibodies. BioTechniques. 26:484-494 Mar. 1999.

Gragg, J. L. Synthesis of Near-Infrared Heptamethine Cyanine Dyes. Chemistry Theses. Paper 28 (2010). http://digitalarchive.gsu.edu/chemistry_theses/28.

MacBeath, G. and S.L. Schreiber. Printing Proteins as Microarrays for High-Throughput Function Determination. Science. vol. 289, pp. 1760-1763, Sep. 8, 2000.

Manders, E.M.M. et al. Direct Imaging of DNA in Living Cells Reveals the Dynamics of Chromosome Formation. The Journal of Cell Biology. vol. 144, No. 5, Mar. 8, 1999 813-821.

Mank, A.J.G. et al., Visible Diode Laser-Induced Fluorescence Detection in Liquid Chromatography after Precolumn Derivatization of Amines. Anal. Chem. vol. 67, pp. 1742-1748, 1995.

Mujumdar, R.B. et al. Cyanine Dye Labeling Reagents: Sulfoindocyanine Succinimidyl Esters. Bioconjug Chem. vol. 4, No. 2, pp. 105-111, Mar./Apr. 1993.

Patonay, G., et al. Noncovalent Labeling of Biomolecules with Red and Near-Infrared Dyes. Molecules. 9, 40-49, 2004.

Pharmacia Biotech. Table of Contents p. 294 and p. 295 of the Pharmacia Biotech Catalogue. 1994.

Roman, B.L. et al. Non-Radioisotopic AFLP Method Using PCR Primers Fluorescently Labeled with Cy™ 5. BioTechniques. vol. 26, No. 2, pp. 236-238,Feb. 1999.

Schena, M. et al. Parallel human genome analysis: Microarray-based expression monitoring of 1000 genes. Proc. Natl. Acad. Sci. USA. vol. 93, pp. 10614-10619, Oct. 1996.

Shao, F. et al. Monofunctional Carbocyanine Dyes for Bio- and Bioorthogonal Conjugation. Bioconjugate Chemistry. 19(12): 2487-2491, Dec. 2008.

Voss, H. et al. Automated Cycle Sequencing with Taquenase™: Protocols for Internal Labeling, Dye Primer and "Doublex" Simultaneous Sequencing. BioTechniques. vol. 23, No. 2, pp. 312-318, Aug. 1997.

Licha et al. Synthesis and Characterization of Cyanine Dye—Poly(ethylene Glycol) Conjugates as Contrast Agents for In Vivo Fluorescence Imaging. SPIE 3196 (1998) 98-102.

Riefke et al. Tumor Detection with Cyanine Dye—Poly(ethylene Glycol) Conjugates as Contrast Agents for Near-Infrared Imaging. SPIE 3196 (1998) 103-110.

* cited by examiner

FIG. 1

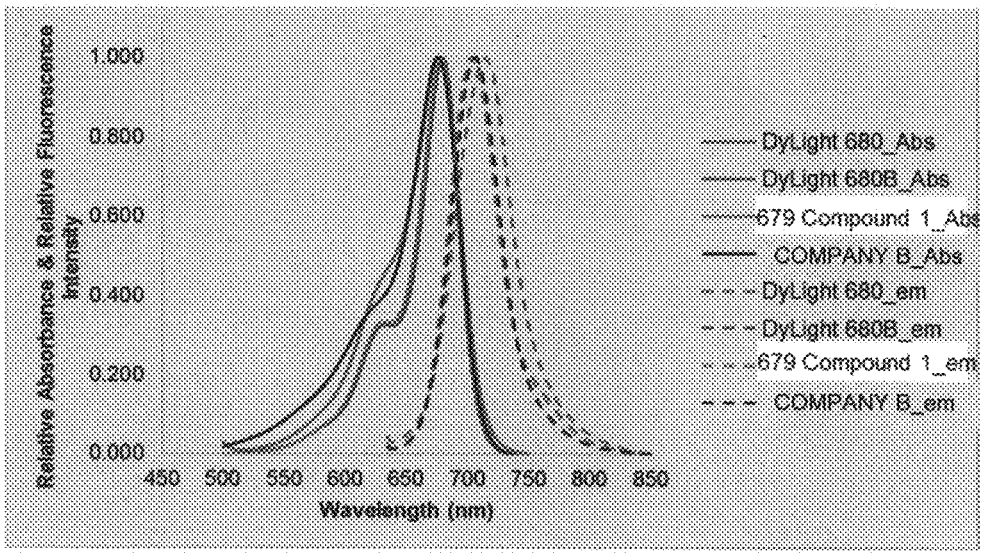
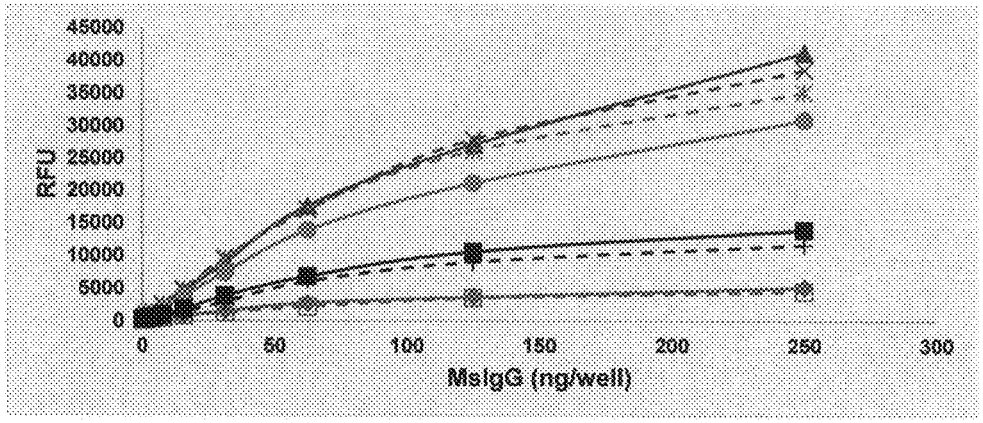

Relative Absorbance & Relative Fluorescence Intensity
1.000
0.800
0.600
0.400
0.200
0.000
450 500 550 600 650 700 750 800 850
Wavelength (nm)
DyLight 680_Abs
DyLight 680B_Abs
679 Compound 1_Abs
COMPANY B_Abs
DyLight 680_em
DyLight 680B_em
679 Compound 1_em
COMPANY B_em

FIG. 2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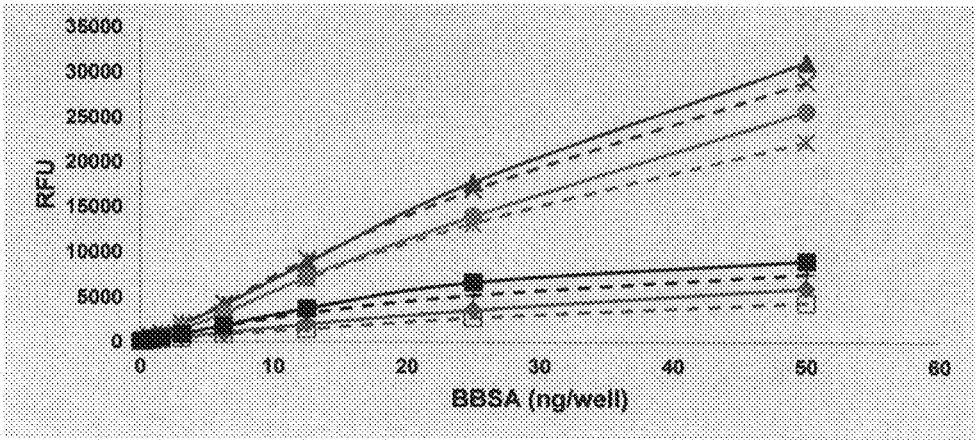
40000
35000
30000
25000
20000
15000
10000
5000
0
0 50 100 150 200 250 300
MsIgG (ng/well)

FIG. 3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30000
25000
20000
15000
10000
5000
0
RFU
0
10
20
30
40
50
60
BBSA (ng/well)

FIG. 4

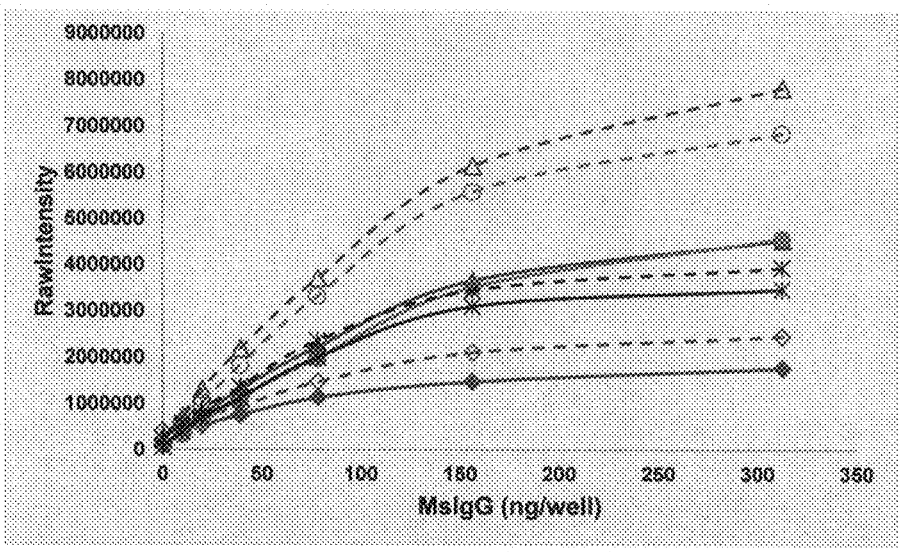
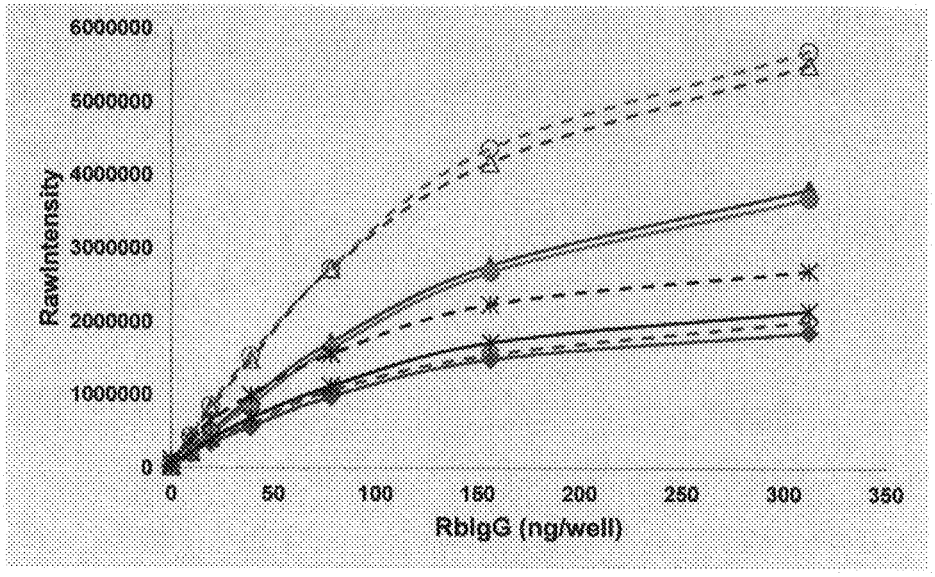

9000000
8000000
7000000
6000000
5000000
4000000
3000000
2000000
1000000
0
RawIntensity
0
50
100
150
200
250
300
350
MsIgG (ng/well)

FIG. 5


6000000
5000000
4000000
3000000
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1000000
0
RawIntensity
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100
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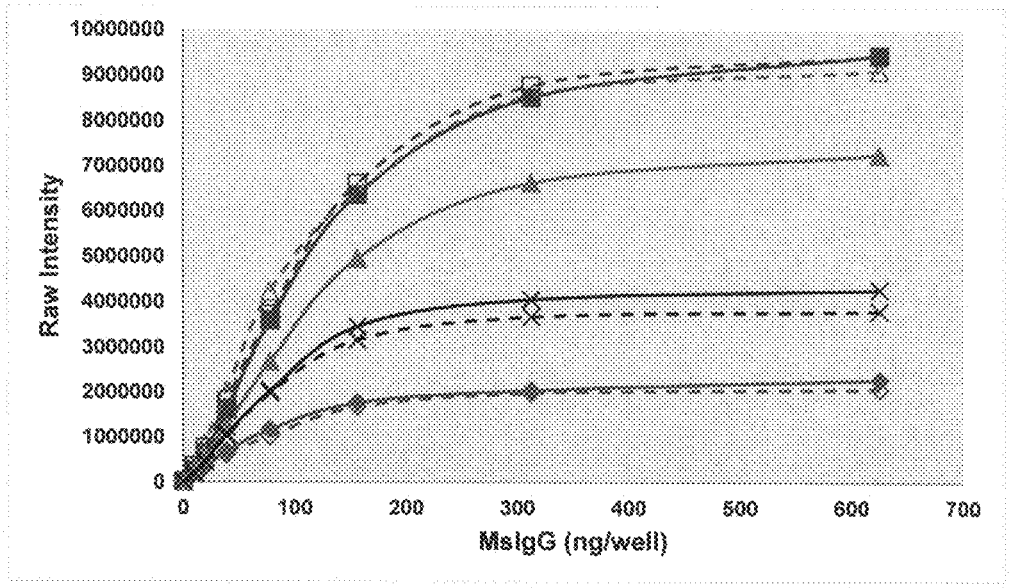
200
250
300
350
RbIgG (ng/well)

FIG. 6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9000000
8000000
7000000
6000000
5000000
4000000
3000000
2000000
1000000
0
Raw Intensity
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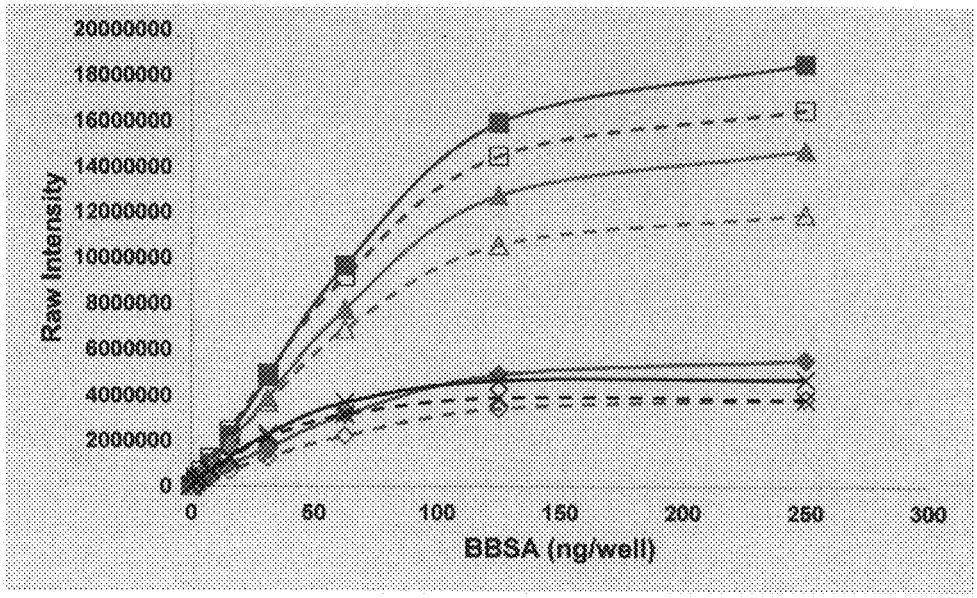
100
200
300
400
500
600
700
MsIgG (ng/well)

FIG. 7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16000000
14000000
12000000
10000000
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2000000
0
Raw Intensity
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100
150
200
250
300
BBSA (ng/well)

FIG. 8

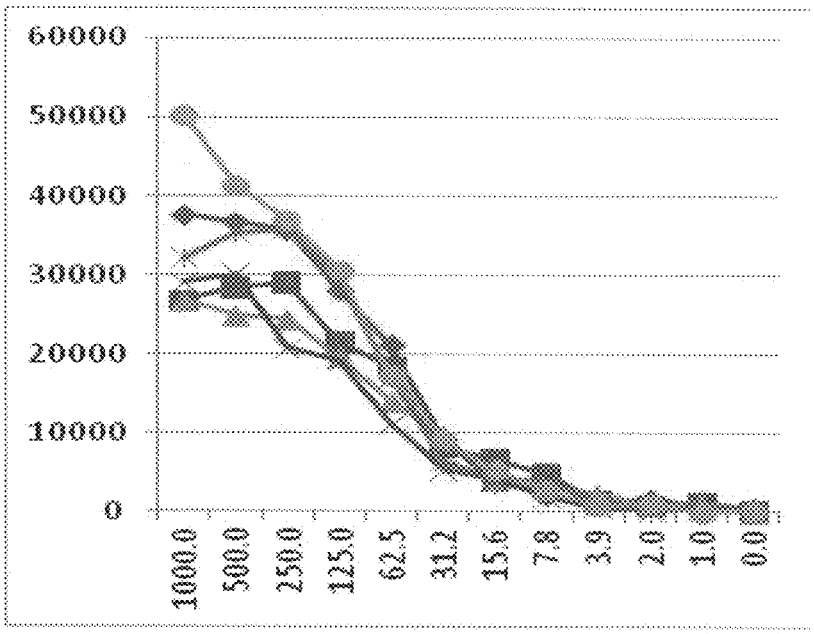
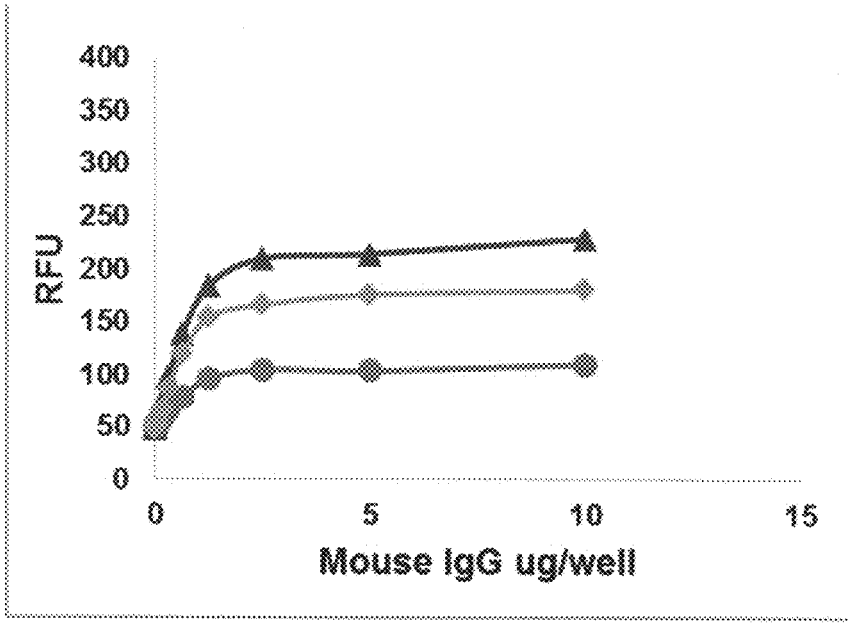

60000
50000
40000
30000
20000
10000
0
1000.0
500.0
250.0
125.0
62.5
31.2
15.6
7.8
3.9
2.0
1.0
0.0

FIG. 9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300
250
200
150
100
50
0
RFU
0
5
10
15
Mouse IgG ug/well

FIG. 10

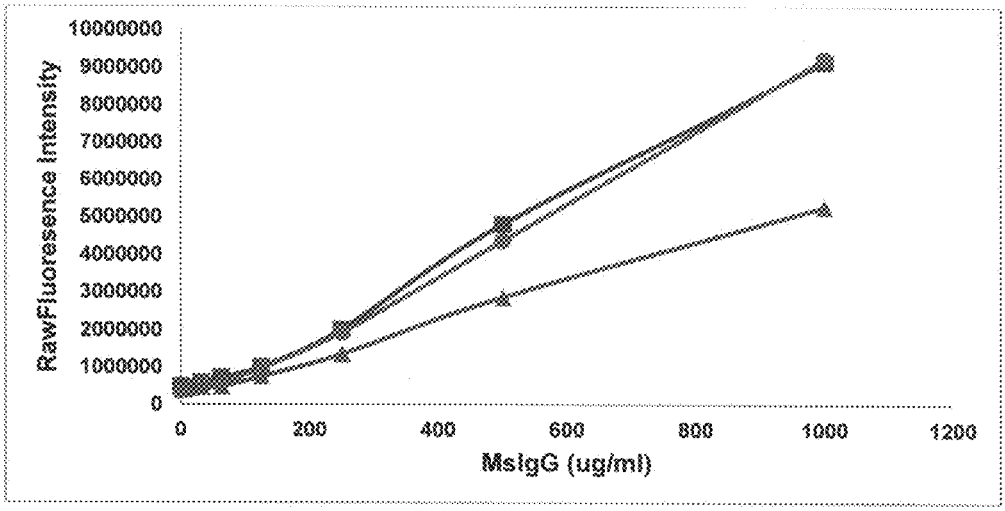

10000000
9000000
8000000
7000000
6000000
5000000
4000000
3000000
2000000
1000000
0
RawFluoresence Intensity
0
200
400
600
800
1000
1200
MsIgG (ug/ml)

FIG. 11

Signal/Background	@ 125ng/well
V08-15173-2.5X	2.2
V08-15173-5X	2.1
V08-15173-10X	2.4
V08-15173-15X	2.0
COMPANY A-680-2.5X	2.8
COMPANY A-5X	2.8
COMPANY A-7.5X	2.3
COMPANY A-15X	2.4
679 Compound 1/1-2.5X	1.2
679 Compound 1/1-5X	1.9
679 Compound 1/1-10X	1.8
679 Compound 1/1-15X	3.9

FIG. 12

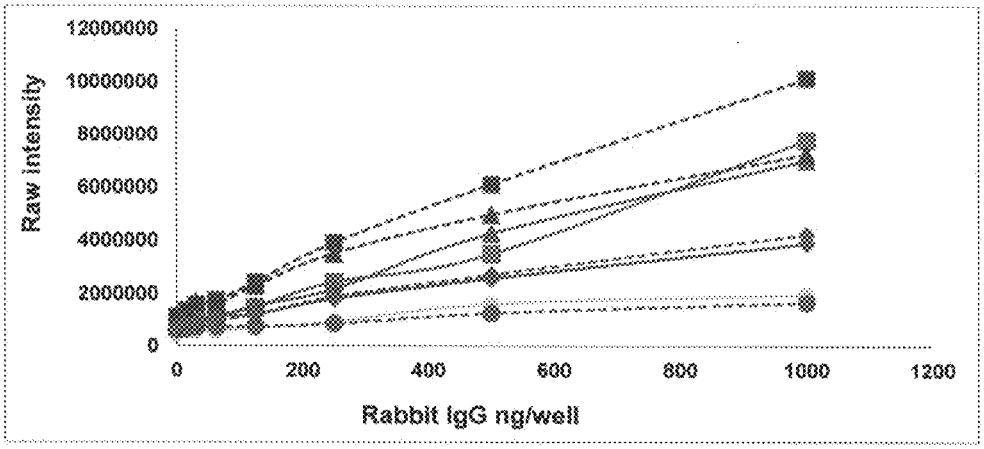


FIG. 13

Signal/ Background	@ 125ng/well
V08-15173-5X	2.1
V08-15173-15X	1.8
V08-15173-25X	2.2
COMPANY A-5X	1.9
COMPANY A-15X	1.8
COMPANY A-25X	1.9
V10-04152-5X	1.4
V10-04152-15X	1.3
V10-04152-25X	1.3
679 Compound 1/1-5X	1.6
679 Compound 1/1-15X	1.8
679 Compound 1/1-25X	1.7

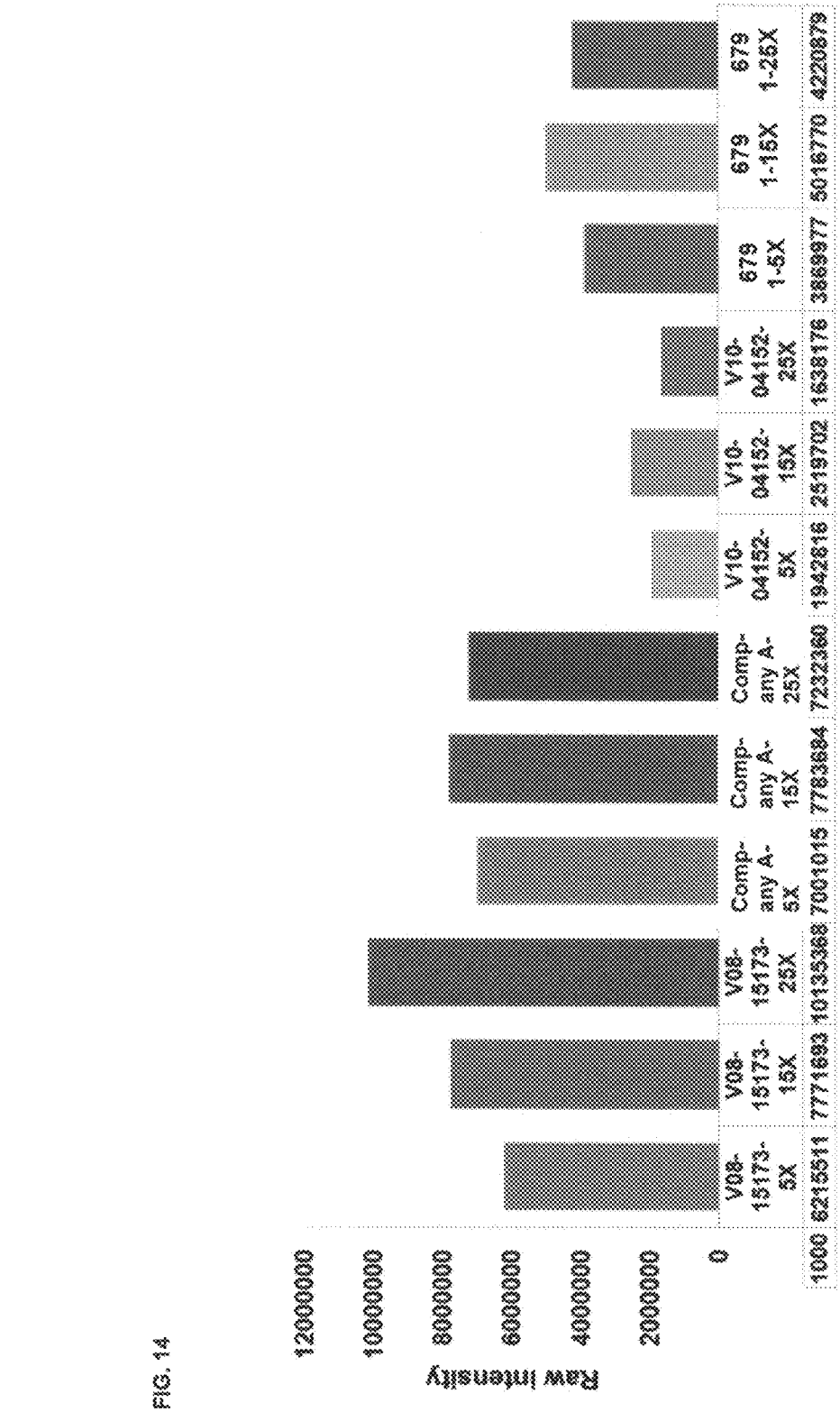

Raw Intensity
12000000
10000000
8000000
6000000
4000000
2000000
0
1000
6215511
7771693
10135368
7001015
7763884
7232360
1942616
2519702
1638176
3869977
5016770
4220879
V08-15173-5X
V08-15173-15X
V08-15173-25X
Comp-any A-5X
Comp-any A-15X
Comp-any A-25X
V10-04152-5X
V10-04152-15X
V10-04152-25X
679 1-5X
679 1-15X
679 1-25X

FIG. 14

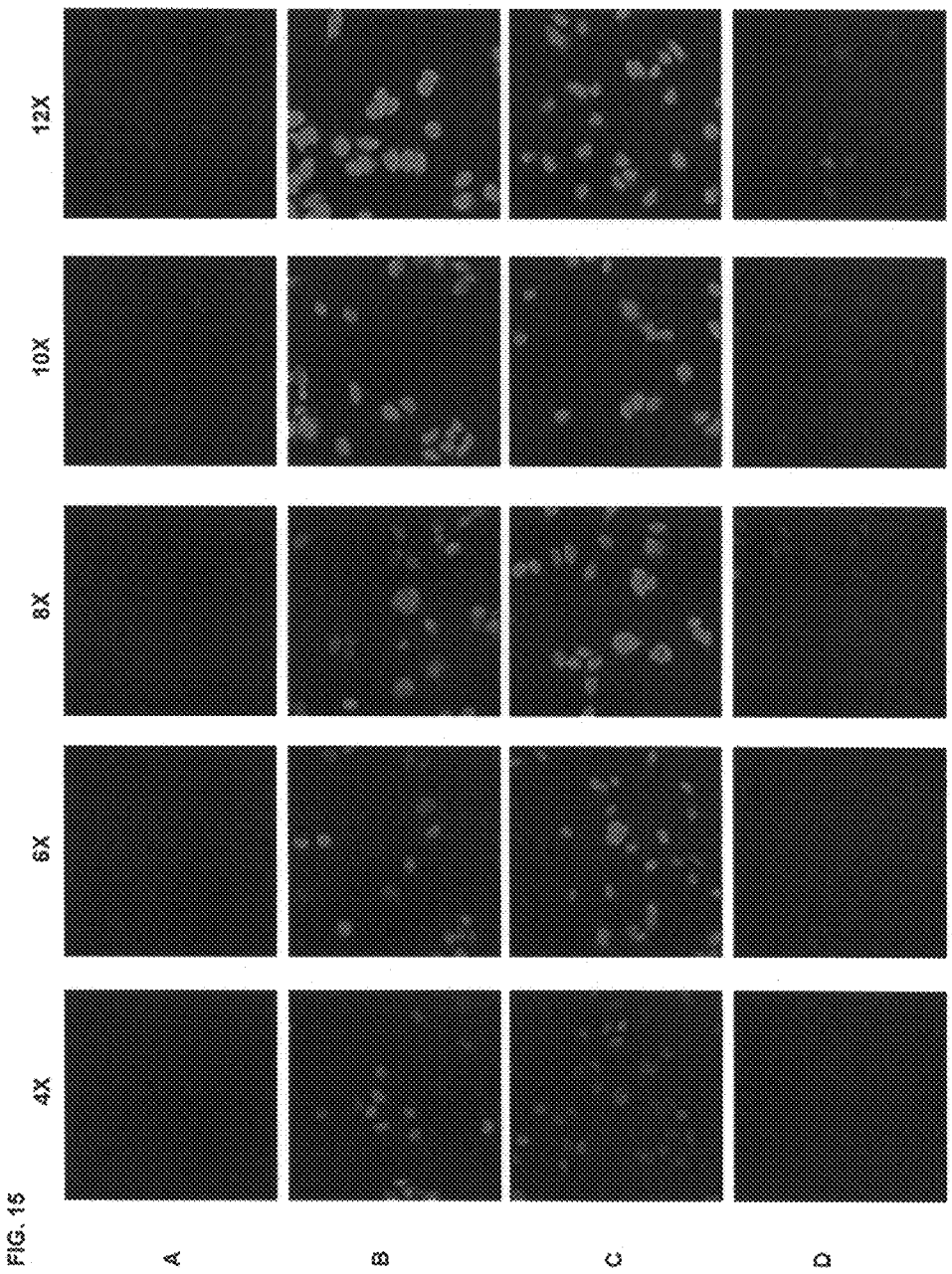


FIG. 15

FIG. 1B

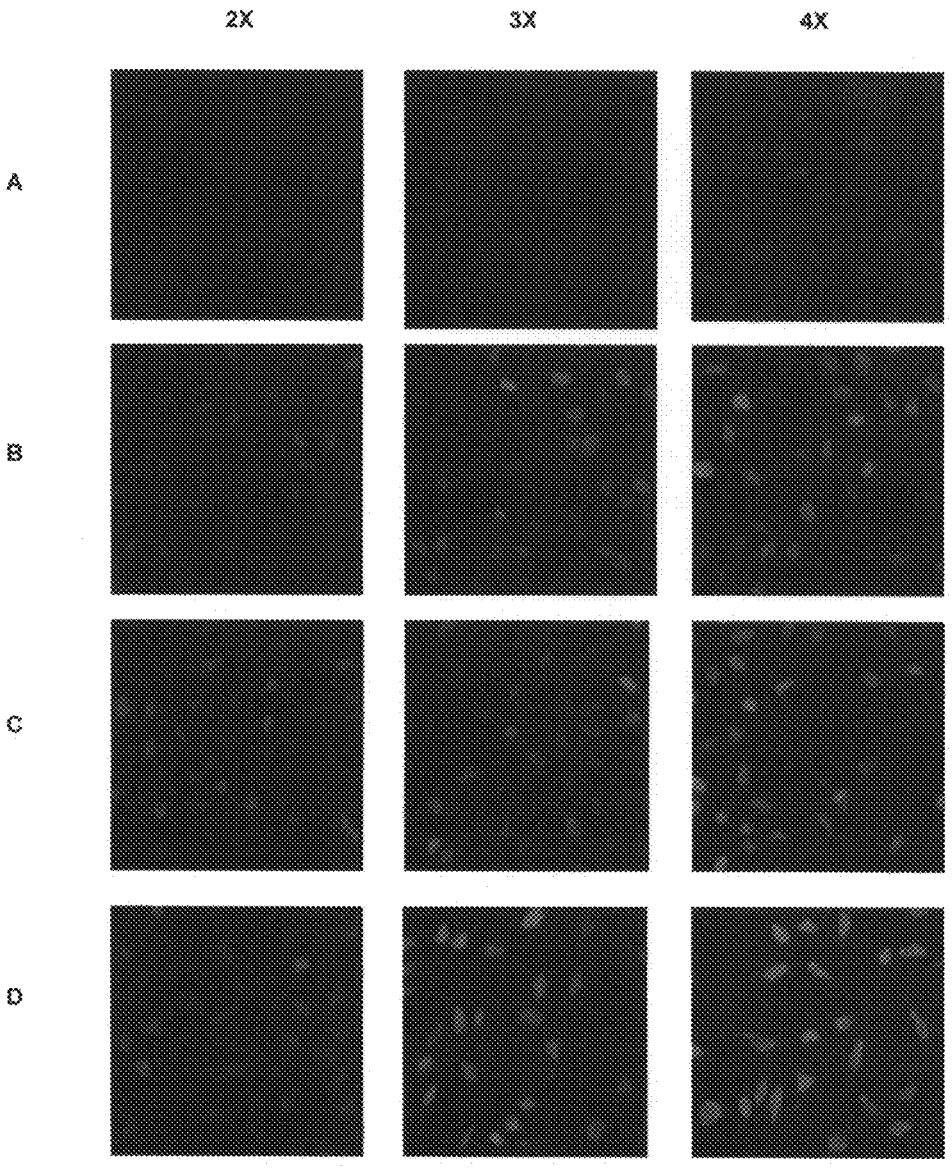


FIG. 17

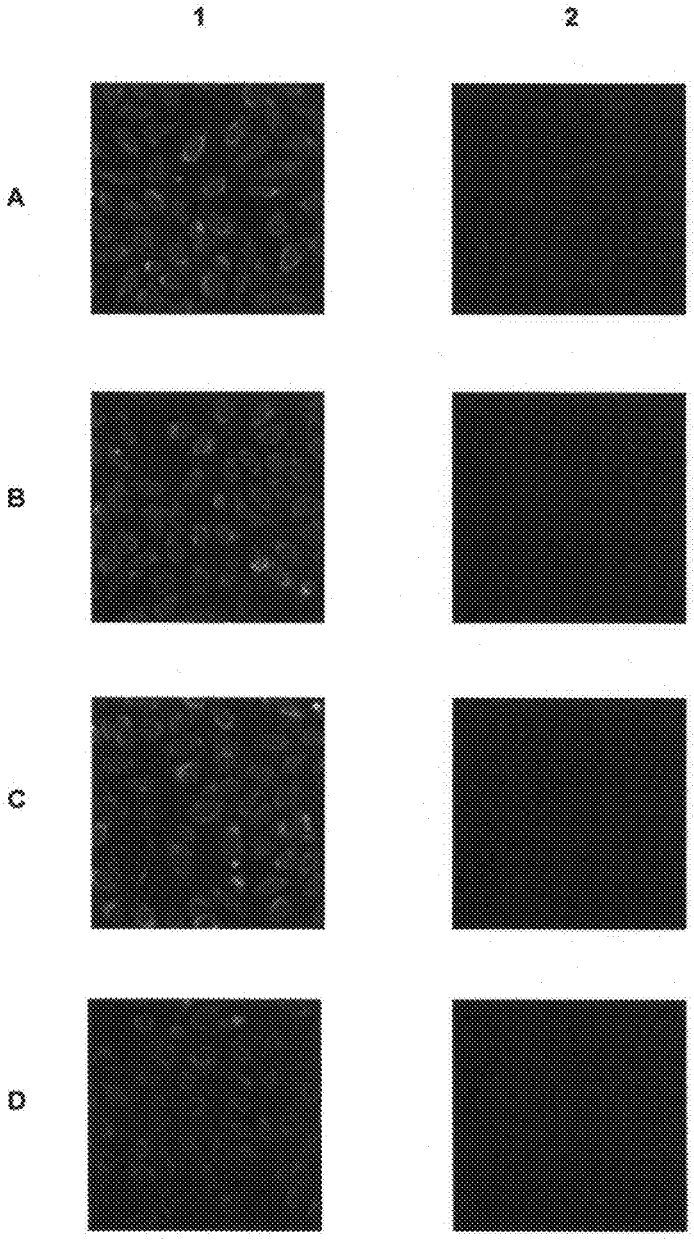


FIG. 18

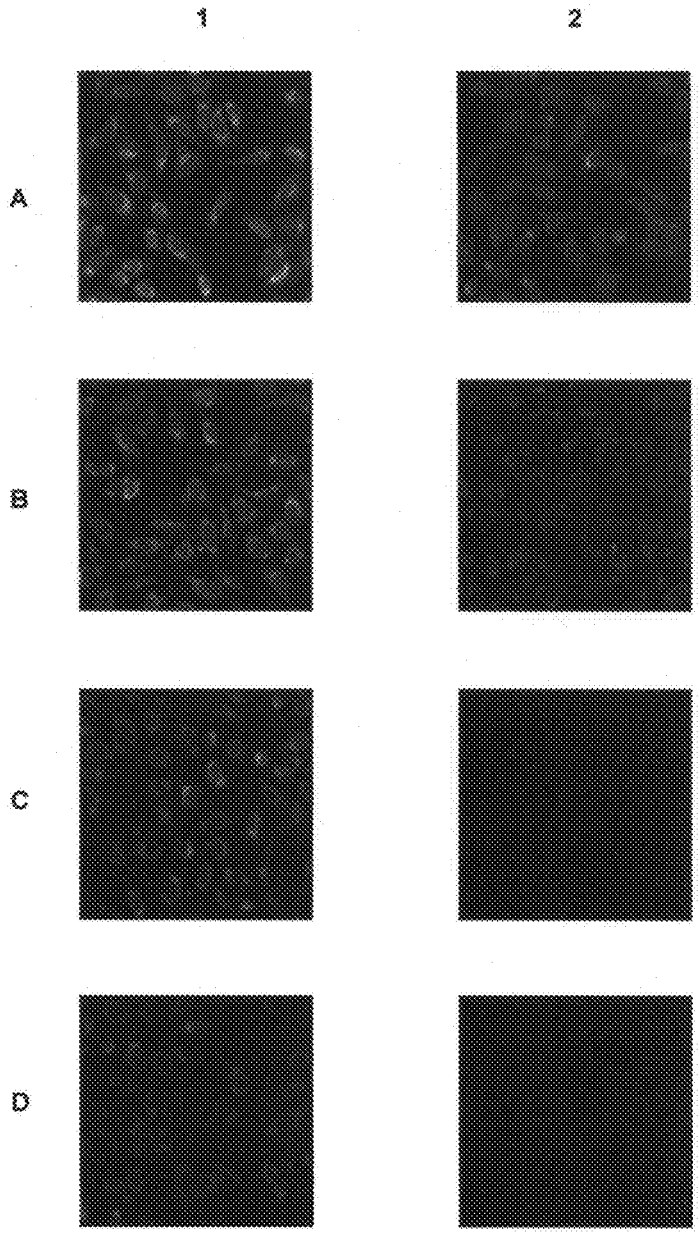


FIG. 19

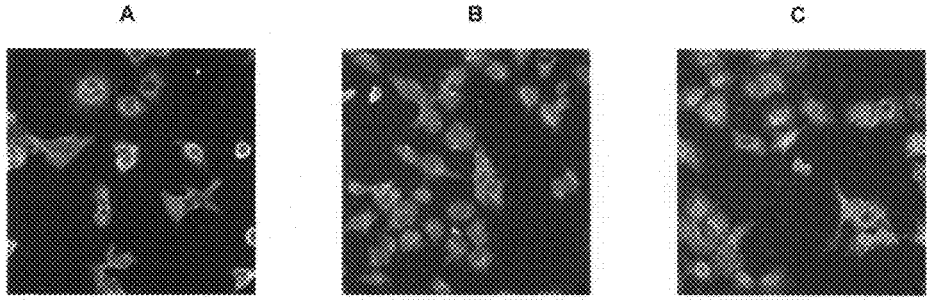


FIG. 20A

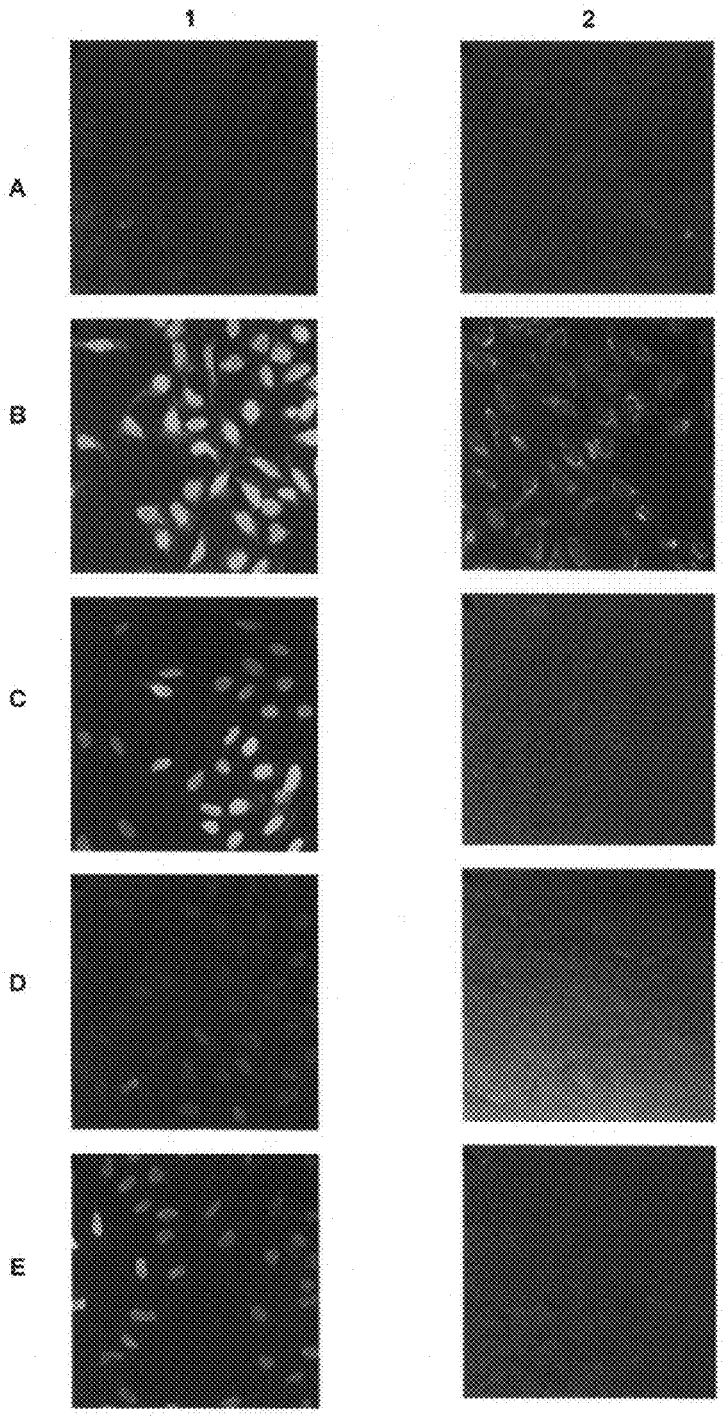


FIG. 20B

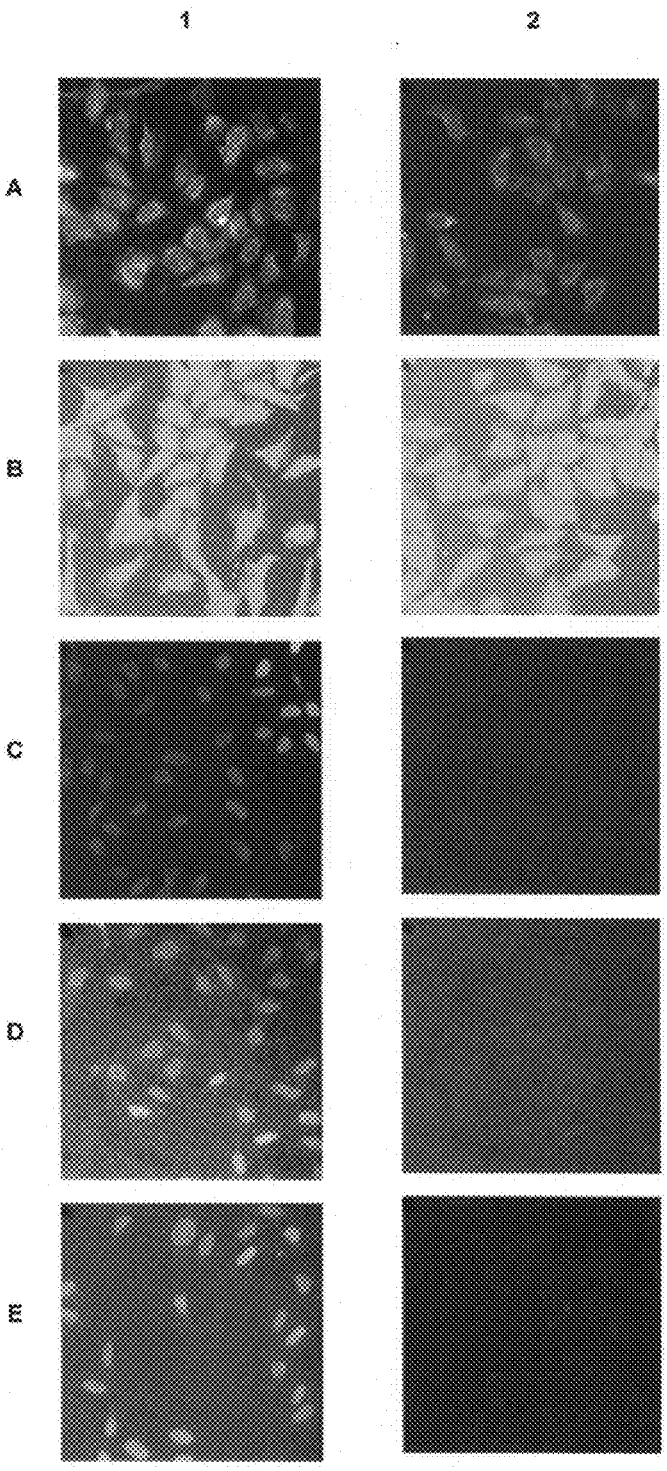
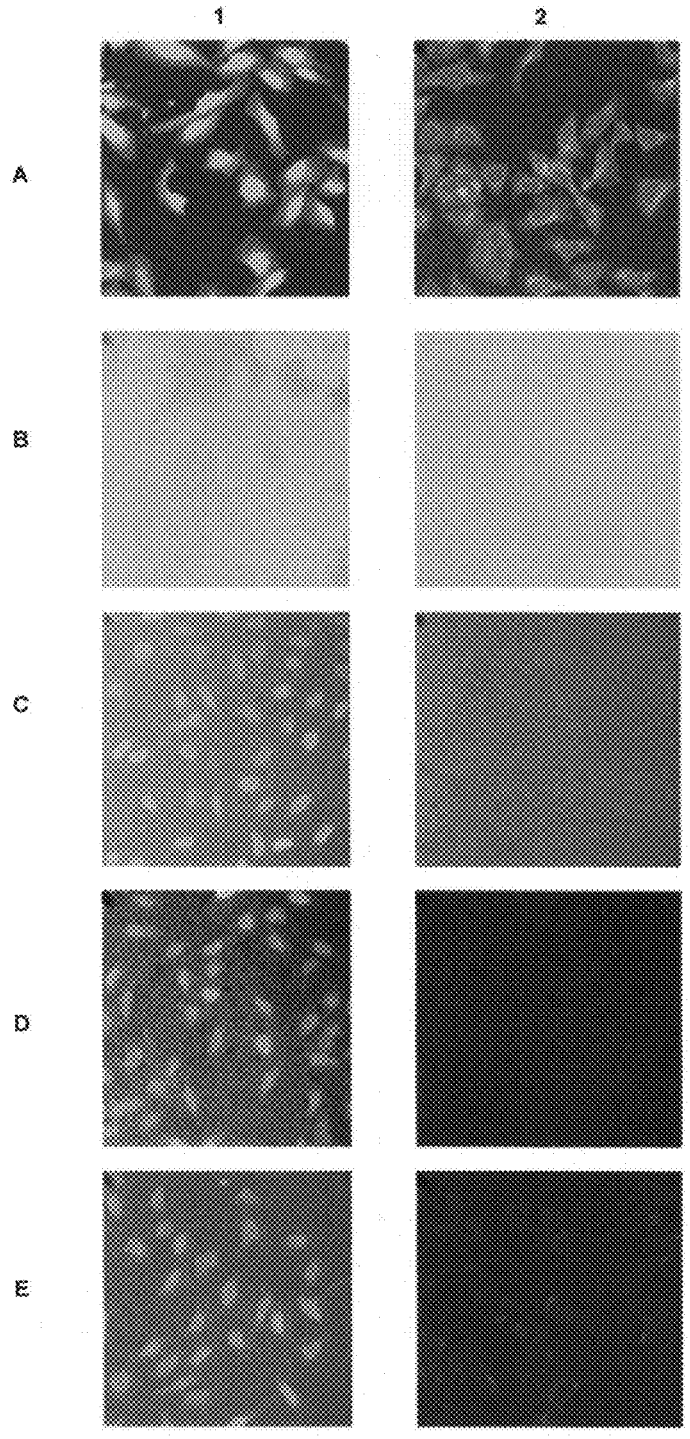


FIG. 20C



BENZOCYANINE COMPOUNDS

This application claims priority to U.S. Application Ser. Nos. 61/524,167 filed Aug. 16, 2011; 61/604,232 filed Feb. 28, 2012; and 61/607,737 filed Mar. 7, 2012, each of which is expressly incorporated by reference herein in its entirety.

Compounds useful as labels with properties comparable to known fluorescent compounds are disclosed. The compounds can be conjugated to proteins and nucleic acids for biological imaging and analysis. Synthesis of the compounds, formation and use of the conjugated compounds, and specific non-limiting examples of each are disclosed.

Compounds that react with biomolecules (e.g., antigens, antibodies, DNA-segments with the corresponding complimentary species for measuring enzyme kinetics, receptor-ligand interactions, nucleic acid hybridization kinetics in vitro as well as in vivo, etc.), termed labels or dyes, are useful for, e.g., pharmacological characterization of receptors and drugs, binding data, etc. Compounds such as xanthylium salts (U.S. Pat. No. 5,846,737) and/or cyanines (U.S. Pat. No. 5,627,027) are used for such applications, but aggregate and form dimers, especially in aqueous solution, due to planarity of their π-system. Compounds that have insufficient hydrophilicity undergo non-specific interactions with various surfaces, resulting in problems when attempting to purify the corresponding conjugate, and an unsatisfactory signal to noise ratio.

Efforts are directed to reducing undesirable properties by introducing substituents that increase the hydrophilicity of the compounds. For example, sulfonic acid function substituents have been introduced into the cyanine chromophore. U.S. Pat. No. 6,083,485 (Licha) and U.S. Pat. Nos. 6,977,305, and 6,974,873 (Molecular Probes) disclose cyanine compounds having one of the common methyl groups in the 3-position of the terminal indole heterocycle substituted by an ω-carboxyalkyl function, and in which the previously present (e.g. in Cy3 or Cy5) N-alkyl or N-ω-carboxyalkyl functions are replaced by N-ω-alkyl sulfonic acid functions. WO 05/044923 discloses cyanine compounds having the common methyl substituent in the 3-position of the terminal indole heterocycle substituted by a N-ω-alkyl sulfonic acid function. In these publications, cyanine compounds having more than two sulfonic acid function substituents exhibited higher solubility and correspondingly a lower tendency to dimer formation, in comparison to cyanine compounds (Cy3, Cy5) described in U.S. Pat. No. 5,627,027.

The disclosed benzocyanine compounds are useful as labels in optical, e.g., fluorescence optical, determination and detection methods. The compounds have high hydrophilicity, high molar absorbance, high photo-stability, and high storage stability. These compounds were excited by monochromatic (e.g., lasers, laser diodes) or polychromatic (e.g., white light sources) light in the ultraviolet (UV), visible, and near infrared (NIR) spectral region to generate emission of fluorescence light.

Typical application methods are based on the reaction of the compounds with biomolecules, e.g., proteins (e.g., antigens, antibodies, etc.), DNA and/or RNA segments, etc. with the corresponding complimentary species. Thus, among other embodiments, the compounds are used to measure enzyme kinetics, receptor-ligand interactions, and nucleic acid hybridization kinetics in vitro and/or in vivo. The compounds are used for the pharmacological characterization of receptors and/or drugs. Applications include, but are not limited to, uses in medicine, pharmacy, biological sciences, materials sciences, environmental control, detection of organic and inorganic micro samples occurring in nature, etc.

The following nomenclature is used to describe the embodiments of the compounds having either a single PEG or multiple PEGs:

The following nomenclature is used for compounds having one ethylene glycol or one (poly)ethylene glycol, which is always at the indole N on the left side of the cyanine: (the first compound is explained in detail, and all other compounds follow this same nomenclature format):

579 Compound 1 ((ethylene glycol) (e.g., is a 579 compound, 1 is the length of the ethylene glycol))
579 Compound 2 (diethylene glycol)
579 Compound 3 (polyethylene glycol (3))
579 Compound 4 (polyethylene glycol (4))
579 Compound 5 (polyethylene glycol (5))
579 Compound 6 (polyethylene glycol (6))
679 Compound 1 (ethylene glycol)
679 Compound 2 (diethylene glycol)
679 Compound 3 (polyethylene glycol (3))
679 Compound 4 (polyethylene glycol (4))
679 Compound 5 (polyethylene glycol (5))
679 Compound 6 (polyethylene glycol (6))
779 Compound 1 (ethylene glycol)
779 Compound 2 (diethylene glycol)
779 Compound 3 (polyethylene glycol (3))
779 Compound 4 (polyethylene glycol (4))
779 Compound 5 (polyethylene glycol (5))
779 Compound 6 (polyethylene glycol (6))

The following nomenclature is used for compounds having more than one ethylene glycol or more than one (poly)ethylene glycol; i.e., one is always at the indole N on the left side of the cyanine, and at least 1 more (2 total) at a site(s) other than the indole N on the left side of the cyanine (the first compound is explained in detail, and all other compounds follow this same nomenclature format):

579 Compound 1/X (e.g., compound 1 is the length of the PEG at the left portion on the cyanine; X is the total number of PEGs on the entire compound).
579 Compound 2/X
579 Compound 3/X
579 Compound 4/X
579 Compound 5/X
579 Compound 6/X
679 Compound 1/X
679 Compound 2/X
679 Compound 3/X
679 Compound 4/X
679 Compound 5/X
679 Compound 6/X
779 Compound 1/X
779 Compound 2/X
779 Compound 3/X
779 Compound 4/X
779 Compound 5/X
779 Compound 6/X

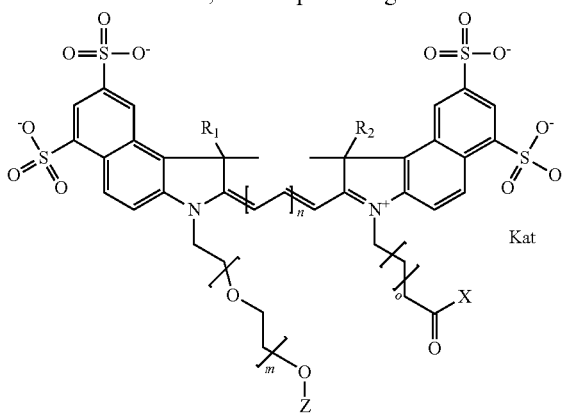
Thus, 579, 679, and 779 compounds comprise a polymethine chain of 3 C, 5 C, and 7 C atoms, respectively, the first 1-6 number refers to the length of a PEG group on an indole N position, e.g., 1 is ethylene glycol (PEG_1), 2 is diethylene glycol (PEG_2), 3 is polyethylene glycol (3) (PEG_3), 4 is polyethylene glycol (4) (PEG_4), 5 is polyethylene glycol (5) (PEG_5), and 6 is polyethylene glycol (6) (PEG_6), and X refers to the number of PEG groups on the compound. For example, in one embodiment, 679 Compound 4/4 means a PEG_4 on an indole N and a total of four PEG groups on the compound.

In one embodiment, the benzocyanine compounds have, in an N-position of one heterocycle, an ethylene glycol group or an ethylene glycol polymer (i.e., poly(ethylene)glycol, collectively abbreviated as PEG), and the other heterocycle has, in an N-position, a function for conjugating the compound to a biomolecule. In one embodiment, the benzocyanine com-

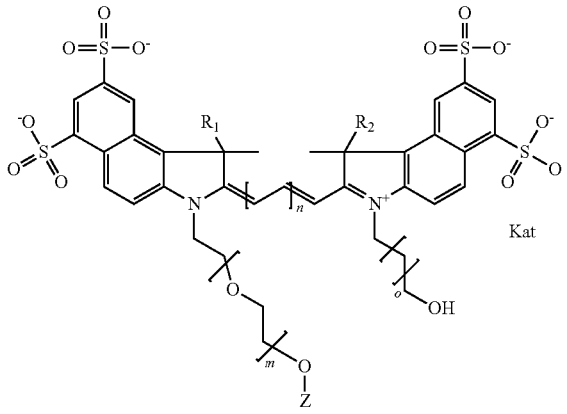
pound has, in any position of the compound, at least one sulfo (SO_3^-) and/or sulfoalkyl group. In one embodiment, the benzocyanine compound has, in any position of the compound, a sulfonamide and/or carboxamide group comprising an ethylene glycol group or an ethylene glycol polymer (i.e., poly(ethylene)glycol, collectively abbreviated as PEG), either directly or indirectly attached to the compound. Indirect attachment indicates use of a linker, direct attachment indicates lack of such a linker. A linker can be any moiety.

In one embodiment, the benzocyanine compounds have, in an N-position of one heterocycle, an ethylene glycol group or an ethylene glycol polymer (i.e., poly(ethylene)glycol, collectively abbreviated as PEG), and the other heterocycle has, in a N-position, an ethylene glycol group or an ethylene glycol polymer (i.e., poly(ethylene)glycol, collectively abbreviated as PEG) and a function for conjugating the compound to a biomolecule. In one embodiment, the benzocyanine compounds have an ethylene glycol group or an ethylene glycol polymer (i.e., poly(ethylene)glycol, collectively abbreviated as PEG) in another position of the benzocyanine compound. In one embodiment, the benzocyanine compound has, in any position of the compound, at least one sulfo and/or sulfoalkyl group. In one embodiment, the benzocyanine compound has, in any position of the compound, a sulfonamide and/or carboxamide group comprising an ethylene glycol group or an ethylene glycol polymer (i.e., poly(ethylene) glycol, collectively abbreviated as PEG), either directly or indirectly attached to the compound.

In one embodiment, the compound is general formula Ia



or general formula Ib



where each of R^1 and R^2 is the same or different and is independently selected from the group consisting of an aliphatic, heteroaliphatic, sulfoalkyl group, heteroaliphatic with terminal SO_3, a PEG group P—Z where P is selected from an ethylene glycol group, a diethylene glycol group, and a polyethylene glycol group, where the polyethylene glycol group is $(CH_2CH_2O)_s$, where s is an integer from 3-6 inclusive, a sulfonamide group -L-SO_2NH—P—Z, and a carboxamide group -L-CONH—P—Z, and Z is selected from H, a CH_3, a CH_3 group, an alkyl group, a heteroalkyl group, or —CO—NHS; X is selected from the group consisting of —OH, —SH, —NH_2, —NH—NH_2, —F, —Cl, —Br, I, —NHS hydroxysuccinimidyl/sulfosuccinimidyl), —O-TFP (2,3,5,6-tetrafluorophenoxy), —O-STP (4-sulfo-2,3,5,6-tetrafluorophenoxy), —O-benzotriazole, -benzotriazole, —NR-L-OH, —NR-L-O-phosphoramidite, —NR-L-SH, —NR-L-NH_2, —NR-L-NH—NH_2, —NR-L-CO_2H, —NR-L-CO—NHS, —NR-L-CO-STP, —NR-L-CO-TFP, —NR-L-CO-benzotriazole, —NR-L-CHO, —NR-L-maleimide, —NR-L-NH—CO—CH2-, imidazole, azide, —NR-L-O—NH_2, and —NR-L-O—CO—NHS, where R is —H or an aliphatic or heteroaliphatic group, and L is selected from the group consisting of a divalent linear (—$(CH_2)_t$—, t=0 to 15), crossed, or cyclic alkyl group optionally substituted by at least one oxygen atom and/or sulfur atom; Kat is a number of Na^+, K^+, Ca^{2+}, ammonia, or other cation(s) needed to compensate the negative charge brought by the cyanine; m is an integer from 0 to 5 inclusive; o is an integer from 0 to 12 inclusive; and n is an integer from 1 to 3 inclusive. In one embodiment, at least one of R^1 and R^2 contains a PEG group.

In one embodiment, the PEG group P is selected from the group consisting of —C—C—O—C (ethylene glycol with terminal methyl), —C—C—O—C—C—O—C (diethylene glycol with terminal methyl), —C—C—O—C—C—O—C—C—O—C (polyethylene glycol (3) with terminal methyl), —C—C—O—C—C—O—C—C—O—C—C—O—C (polyethylene glycol (4) with terminal methyl), —C—C—O—C—C—O—C—C—O—C—C—O—C—C—O—C (polyethylene glycol (5) with terminal methyl), and C—C—O—C—C—O—C—C—O—C—C—O—C—C—O—C—C—O—C (polyethylene glycol (6) with terminal methyl). In one embodiment, the PEG group P may be either uncapped, e.g., lack a terminal methyl, or may be capped with an atom or group other than a methyl. In one embodiment, the PEG group P terminates with a Z group, where Z is selected from H, CH_3, a CH_3 group, an alkyl group, or a heteroalkyl group.

In one embodiment, the compound is general formula Ia or general formula Ib, collectively referred to as general formula I, where R1 is methyl and R2 is sulfoalkyl; X is —OH, —NHS, —O-TFP, or —NR-L-maleimide; m is 0; o is 3; and n is 1. In one embodiment, the compound is general formula I, where R1 is methyl and R2 is sulfoalkyl; X is —OH, —NHS, —O-TFP, or —NR-L-maleimide; m is 1; o is 3; and n is 1. In one embodiment, the compound is general formula I, where R1 is methyl and R2 is sulfoalkyl; X is —OH, —NHS, —O-TFP, or —NR-L-maleimide; m is 2; o is 3; and n is 1. In one embodiment, the compound is general formula I, where R1 is methyl and R2 is sulfoalkyl; X is —OH, —NHS, —O-TFP, or —NR-L-maleimide; m is 3; o is 3; and n is 1. In one embodiment, the compound is general formula I, where R1 is methyl and R2 is sulfoalkyl; X is —OH, —NHS, —O-TFP, or —NR-L-maleimide; m is 4; o is 3; and n is 1. In one embodiment, the compound is general formula I, where R1 is methyl and R2 is sulfoalkyl; X is —OH, —NHS, —O-TFP, or —NR-L-maleimide; m is 5; o is 3; and n is 1.

In one embodiment, the compound is general formula I, where R1 is methyl and R2 is sulfoalkyl; X is —OH, —NHS, —O-TFP, or —NR-L-maleimide; m is 0; o is 3; and n is 2. In

one embodiment, the compound is general formula I, where R1 is methyl and R2 is sulfoalkyl; X is —OH, —NHS, —O-TFP, or —NR-L-maleimide; m is 1; o is 3; and n is 2. In one embodiment, the compound is general formula I, where R1 is methyl and R2 is sulfoalkyl; X is —OH, —NHS, —O-TFP, or —NR-L-maleimide; m is 2; o is 3; and n is 2. In one embodiment, the compound is general formula I, where R1 is methyl and R2 is sulfoalkyl; X is —OH, —NHS, —O-TFP, or —NR-L-maleimide; m is 3; o is 3; and n is 2. In one embodiment, the compound is general formula I, where R1 is methyl and R2 is sulfoalkyl; X is —OH, —NHS, —O-TFP, or —NR-L-maleimide; m is 4; o is 3; and n is 2. In one embodiment, the compound is general formula I, where R1 is methyl and R2 is sulfoalkyl; X is —OH, —NHS, —O-TFP, or —NR-L-maleimide; m is 5; o is 3; and n is 2.

In one embodiment, the compound is general formula I, where R1 is methyl and R2 is sulfoalkyl; X is —OH, —NHS, —O-TFP, or —NR-L-maleimide; m is 0; o is 3; and n is 3. In one embodiment, the compound is general formula I, where R1 is methyl and R2 is sulfoalkyl; X is —OH, —NHS, —O-TFP, or —NR-L-maleimide; m is 1; o is 3; and n is 3. In one embodiment, the compound is general formula I, where R1 is methyl and R2 is sulfoalkyl; X is —OH, —NHS, —O-TFP, or —NR-L-maleimide; m is 2; o is 3; and n is 3. In one embodiment, the compound is general formula I, where R1 is methyl and R2 is sulfoalkyl; X is —OH, —NHS, —O-TFP, or —NR-L-maleimide; m is 3; o is 3; and n is 3. In one embodiment, the compound is general formula I, where R1 is methyl and R2 is sulfoalkyl; X is —OH, —NHS, —O-TFP, or —NR-L-maleimide; m is 4; o is 3; and n is 3. In one embodiment, the compound is general formula I, where R1 is methyl and R2 is sulfoalkyl; X is —OH, —NHS, —O-TFP, or —NR-L-maleimide; m is 5; o is 3; and n is 3.

In one embodiment, the compound is general formula I, where R1 is sulfoalkyl and R2 is a PEG group; X is —OH, —NHS, —O-TFP, or —NR-L-maleimide; m is 0; o is 3; and n is 1. In one embodiment, the compound is general formula I, where R1 is sulfoalkyl and R2 is a PEG group; X is —OH, —NHS, —O-TFP, or —NR-L-maleimide; m is 1; o is 3; and n is 1. In one embodiment, the compound is general formula I, where R1 is sulfoalkyl and R2 is a PEG group; X is —OH, —NHS, —O-TFP, or —NR-L-maleimide; m is 2; o is 3; and n is 1. In one embodiment, the compound is general formula I, where R1 is sulfoalkyl and R2 is a PEG group; X is —OH, —NHS, —O-TFP, or —NR-L-maleimide; m is 3; o is 3; and n is 1. In one embodiment, the compound is general formula I, where R1 is sulfoalkyl and R2 is a PEG group; X is —OH, —NHS, —O-TFP, or —NR-L-maleimide; m is 4; o is 3; and n is 1. In one embodiment, the compound is general formula I, where R1 is sulfoalkyl and R2 is a PEG group; X is —OH, —NHS, —O-TFP, or —NR-L-maleimide; m is 5; o is 3; and n is 1.

In one embodiment, the compound is general formula I, where R1 is sulfoalkyl and R2 is a PEG group; X is —OH, —NHS, —O-TFP, or —NR-L-maleimide; m is 0; o is 3; and n is 2. In one embodiment, the compound is general formula I, where R1 is sulfoalkyl and R2 is a PEG group; X is —OH, —NHS, —O-TFP, or —NR-L-maleimide; m is 1; o is 3; and n is 2. In one embodiment, the compound is general formula I, where R1 is sulfoalkyl and R2 is a PEG group; X is —OH, —NHS, —O-TFP, or —NR-L-maleimide; m is 2; o is 3; and n is 2. In one embodiment, the compound is general formula I, where R1 is sulfoalkyl and R2 is a PEG group; X is —OH, —NHS, —O-TFP, or —NR-L-maleimide; m is 3; o is 3; and n is 2. In one embodiment, the compound is general formula I, where R1 is sulfoalkyl and R2 is a PEG group; X is —OH, —NHS, —O-TFP, or —NR-L-maleimide; m is 4; o is 3; and n is 2. In one embodiment, the compound is general formula I, where R1 is sulfoalkyl and R2 is a PEG group; X is —OH, —NHS, —O-TFP, or —NR-L-maleimide; m is 5; o is 3; and n is 2.

In one embodiment, the compound is general formula I, where R1 is sulfoalkyl and R2 is a PEG group; X is —OH, —NHS, —O-TFP, or —NR-L-maleimide; m is 0; o is 3; and n is 3. In one embodiment, the compound is general formula I, where R1 is sulfoalkyl and R2 is a PEG group; X is —OH, —NHS, —O-TFP, or —NR-L-maleimide; m is 1; o is 3; and n is 3. In one embodiment, the compound is general formula I, where R1 is sulfoalkyl and R2 is a PEG group; X is —OH, —NHS, —O-TFP, or —NR-L-maleimide; m is 2; o is 3; and n is 3. In one embodiment, the compound is general formula I, where R1 is sulfoalkyl and R2 is a PEG group; X is —OH, —NHS, —O-TFP, or —NR-L-maleimide; m is 3; o is 3; and n is 3. In one embodiment, the compound is general formula I, where R1 is sulfoalkyl and R2 is a PEG group; X is —OH, —NHS, —O-TFP, or —NR-L-maleimide; m is 4; o is 3; and n is 3. In one embodiment, the compound is general formula I, where R1 is sulfoalkyl and R2 is a PEG group; X is —OH, —NHS, —O-TFP, or —NR-L-maleimide; m is 5; o is 3; and n is 3.

In one embodiment, the compound is general formula I, where R1 is methyl and R2 is a PEG group; X is —OH, —NHS, —O-TFP, or —NR-L-maleimide; m is 0; o is 3; and n is 1. In one embodiment, the compound is general formula I, where R1 is methyl and R2 is a PEG group; X is —OH, —NHS, —O-TFP, or —NR-L-maleimide; m is 1; o is 3; and n is 1. In one embodiment, the compound is general formula I, where R1 is methyl and R2 is a PEG group; X is —OH, —NHS, —O-TFP, or —NR-L-maleimide; m is 2; o is 3; and n is 1. In one embodiment, the compound is general formula I, where R1 is methyl and R2 is a PEG group; X is —OH, —NHS, —O-TFP, or —NR-L-maleimide; m is 3; o is 3; and n is 1. In one embodiment, the compound is general formula I, where R1 is methyl and R2 is a PEG group; X is —OH, —NHS, —O-TFP, or —NR-L-maleimide; m is 4; o is 3; and n is 1. In one embodiment, the compound is general formula I, where R1 is methyl and R2 is a PEG group; X is —OH, —NHS, —O-TFP, or —NR-L-maleimide; m is 5; o is 3; and n is 1.

In one embodiment, the compound is general formula I, where R1 is methyl and R2 is a PEG group; X is —OH, —NHS, —O-TFP, or —NR-L-maleimide; m is 0; o is 3; and n is 2. In one embodiment, the compound is general formula I, where R1 is methyl and R2 is a PEG group; X is —OH, —NHS, —O-TFP, or —NR-L-maleimide; m is 1; o is 3; and n is 2. In one embodiment, the compound is general formula I, where R1 is methyl and R2 is a PEG group; X is —OH, —NHS, —O-TFP, or —NR-L-maleimide; m is 2; o is 3; and n is 2. In one embodiment, the compound is general formula I, where R1 is methyl and R2 is a PEG group; X is —OH, —NHS, —O-TFP, or —NR-L-maleimide; m is 3; o is 3; and n is 2. In one embodiment, the compound is general formula I, where R1 is methyl and R2 is a PEG group; X is —OH, —NHS, —O-TFP, or —NR-L-maleimide; m is 4; o is 3; and n is 2. In one embodiment, the compound is general formula I, where R1 is methyl and R2 is a PEG group; X is —OH, —NHS, —O-TFP, or —NR-L-maleimide; m is 5; o is 3; and n is 2.

In one embodiment, the compound is general formula I, where R1 is methyl and R2 is a PEG group; X is —OH, —NHS, —O-TFP, or —NR-L-maleimide; m is 0; o is 3; and n is 3. In one embodiment, the compound is general formula I, where R1 is methyl and R2 is a PEG group; X is —OH, —NHS, —O-TFP, or —NR-L-maleimide; m is 1; o is 3; and

n is 3. In one embodiment, the compound is general formula I, where R1 is methyl and R2 is a PEG group; X is —OH, —NHS, —O-TFP, or —NR-L-maleimide; m is 2; o is 3; and n is 3. In one embodiment, the compound is general formula I, where R1 is methyl and R2 is a PEG group; X is —OH, —NHS, —O-TFP, or —NR-L-maleimide; m is 3; o is 3; and n is 3. In one embodiment, the compound is general formula I, where R1 is methyl and R2 is a PEG group; X is —OH, —NHS, —O-TFP, or —NR-L-maleimide; m is 4; o is 3; and n is 3. In one embodiment, the compound is general formula I, where R1 is methyl and R2 is a PEG group; X is —OH, —NHS, —O-TFP, or —NR-L-maleimide; m is 5; o is 3; and n is 3.

In one embodiment, the compound is general formula I, where each of R1 and R2 is a PEG group; X is —OH, —NHS, —O-TFP, or —NR-L-maleimide; m is 0; o is 3; and n is 1. In one embodiment, the compound is general formula I, where each of R1 and R2 is a PEG group; X is —OH, —NHS, —O-TFP, or —NR-L-maleimide; m is 1; o is 3; and n is 1. In one embodiment, the compound is general formula I, where each of R1 and R2 is a PEG group; X is —OH, —NHS, —O-TFP, or —NR-L-maleimide; m is 2; o is 3; and n is 1. In one embodiment, the compound is general formula I, where each of R1 and R2 is a PEG group; X is —OH, —NHS, —O-TFP, or —NR-L-maleimide; m is 3; o is 3; and n is 1. In one embodiment, the compound is general formula I, where each of R1 and R2 is a PEG group; X is —OH, —NHS, —O-TFP, or —NR-L-maleimide; m is 4; o is 3; and n is 1. In one embodiment, the compound is general formula I, where each of R1 and R2 is a PEG group; X is —OH, —NHS, —O-TFP, or —NR-L-maleimide; m is 5; o is 3; and n is 1.

In one embodiment, the compound is general formula I, where each of R1 and R2 is a PEG group; X is —OH, —NHS, —O-TFP, or —NR-L-maleimide; m is 0; o is 3; and n is 2. In one embodiment, the compound is general formula I, where each of R1 and R2 is a PEG group; X is —OH, —NHS, —O-TFP, or —NR-L-maleimide; m is 1; o is 3; and n is 2. In one embodiment, the compound is general formula I, where each of R1 and R2 is a PEG group; X is —OH, —NHS, —O-TFP, or —NR-L-maleimide; m is 2; o is 3; and n is 2. In one embodiment, the compound is general formula I, where each of R1 and R2 is a PEG group; X is —OH, —NHS, —O-TFP, or —NR-L-maleimide; m is 3; o is 3; and n is 2. In one embodiment, the compound is general formula I, where each of R1 and R2 is a PEG group; X is —OH, —NHS, —O-TFP, or —NR-L-maleimide; m is 4; o is 3; and n is 2. In one embodiment, the compound is general formula I, where each of R1 and R2 is a PEG group; X is —OH, —NHS, —O-TFP, or —NR-L-maleimide; m is 5; o is 3; and n is 2.

In one embodiment, the compound is general formula I, where each of R1 and R2 is a PEG group; X is —OH, —NHS, —O-TFP, or —NR-L-maleimide; m is 0; o is 3; and n is 3. In one embodiment, the compound is general formula I, where each of R1 and R2 is a PEG group; X is —OH, —NHS, —O-TFP, or —NR-L-maleimide; m is 1; o is 3; and n is 3. In one embodiment, the compound is general formula I, where each of R1 and R2 is a PEG group; X is —OH, —NHS, —O-TFP, or —NR-L-maleimide; m is 2; o is 3; and n is 3. In one embodiment, the compound is general formula I, where each of R1 and R2 is a PEG group; X is —OH, —NHS, —O-TFP, or —NR-L-maleimide; m is 3; o is 3; and n is 3. In one embodiment, the compound is general formula I, where each of R1 and R2 is a PEG group; X is —OH, —NHS, —O-TFP, or —NR-L-maleimide; m is 4; o is 3; and n is 3. In one embodiment, the compound is general formula I, where each of R1 and R2 is a PEG group; X is —OH, —NHS, —O-TFP, or —NR-L-maleimide; m is 5; o is 3; and n is 3.

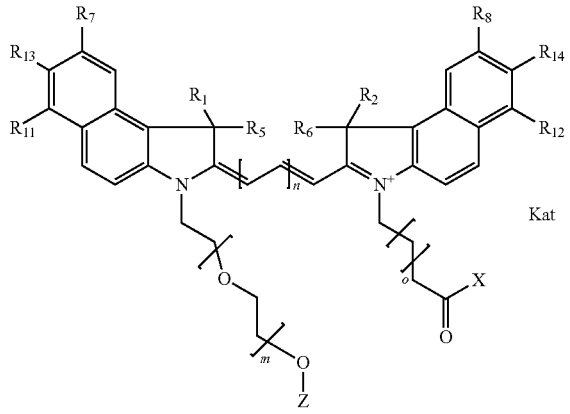
In one embodiment, the compound is general formula I, where R1 is sulfoalkyl and R2 is a sulfonamide group -L-SO_2NH—P where P is a PEG group; X is —OH, —NHS, —O-TFP, or —NR-L-maleimide; m is 0; o is 3; and n is 1. In one embodiment, the compound is general formula I, where R1 is sulfoalkyl and R2 is a sulfonamide group -L-SO_2NH—P where P is a PEG group; X is —OH, —NHS, —O-TFP, or —NR-L-maleimide; m is 1; o is 3; and n is 1. In one embodiment, the compound is general formula I, where R1 is sulfoalkyl and R2 is a sulfonamide group -L-SO_2NH—P where P is a PEG group; X is —OH, —NHS, —O-TFP, or —NR-L-maleimide; m is 2; o is 3; and n is 1. In one embodiment, the compound is general formula I, where R1 is sulfoalkyl and R2 is a sulfonamide group -L-SO_2NH—P where P is a PEG group; X is —OH, —NHS, —O-TFP, or —NR-L-maleimide; m is 3; o is 3; and n is 1. In one embodiment, the compound is general formula I, where R1 is sulfoalkyl and R2 is a sulfonamide group -L-SO_2NH—P where P is a PEG group; X is —OH, —NHS, —O-TFP, or —NR-L-maleimide; m is 4; o is 3; and n is 1. In one embodiment, the compound is general formula I, where R1 is sulfoalkyl and R2 is a sulfonamide group -L-SO_2NH—P where P is a PEG group; X is —OH, —NHS, —O-TFP, or —NR-L-maleimide; m is 5; o is 3; and n is 1.

In one embodiment, the compound is general formula I, where R1 is sulfoalkyl and R2 is a sulfonamide group -L-SO_2NH—P where P is a PEG group; X is —OH, —NHS, —O-TFP, or —NR-L-maleimide; m is 0; o is 3; and n is 2. In one embodiment, the compound is general formula I, where R1 is sulfoalkyl and R2 is a sulfonamide group -L-SO_2NH—P where P is a PEG group; X is —OH, —NHS, —O-TFP, or —NR-L-maleimide; m is 1; o is 3; and n is 2. In one embodiment, the compound is general formula I, where R1 is sulfoalkyl and R2 is a sulfonamide group -L-SO_2NH—P where P is a PEG group; X is —OH, —NHS, —O-TFP, or —NR-L-maleimide; m is 2; o is 3; and n is 2. In one embodiment, the compound is general formula I, where R1 is sulfoalkyl and R2 is a sulfonamide group -L-SO_2NH—P where P is a PEG group; X is —OH, —NHS, —O-TFP, or —NR-L-maleimide; m is 3; o is 3; and n is 2. In one embodiment, the compound is general formula I, where R1 is sulfoalkyl and R2 is a sulfonamide group -L-SO_2NH—P where P is a PEG group; X is —OH, —NHS, —O-TFP, or —NR-L-maleimide; m is 4; o is 3; and n is 2. In one embodiment, the compound is general formula I, where R1 is sulfoalkyl and R2 is a sulfonamide group -L-SO_2NH—P where P is a PEG group; X is —OH, —NHS, —O-TFP, or —NR-L-maleimide; m is 5; o is 3; and n is 2.

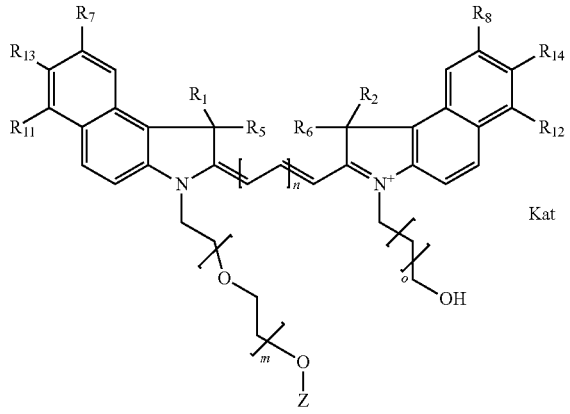
In one embodiment, the compound is general formula I, where R1 is sulfoalkyl and R2 is a sulfonamide group -L-SO_2NH—P where P is a PEG group; X is —OH, —NHS, —O-TFP, or —NR-L-maleimide; m is 0; o is 3; and n is 3. In one embodiment, the compound is general formula I, where R1 is sulfoalkyl and R2 is a sulfonamide group -L-SO_2NH—P where P is a PEG group; X is —OH, —NHS, —O-TFP, or —NR-L-maleimide; m is 1; o is 3; and n is 3. In one embodiment, the compound is general formula I, where R1 is sulfoalkyl and R2 is a sulfonamide group -L-SO_2NH—P where P is a PEG group; X is —OH, —NHS, —O-TFP, or —NR-L-maleimide; m is 2; o is 3; and n is 3. In one embodiment, the compound is general formula I, where R1 is sulfoalkyl and R2 is a sulfonamide group -L-SO_2NH—P where P is a PEG group; X is —OH, —NHS, —O-TFP, or —NR-L-maleimide; m is 3; o is 3; and n is 3. In one embodiment, the compound is general formula I, where R1 is sulfoalkyl and R2 is a sulfonamide group -L-SO_2NH—P where P is a PEG group; X is —OH, —NHS,

—O-TFP, or —NR-L-maleimide; m is 4; o is 3; and n is 3. In one embodiment, the compound is general formula I, where R1 is sulfoalkyl and R2 is a sulfonamide group -L-SO_2NH—P where P is a PEG group; X is —OH, —NHS, —O-TFP, or —NR-L-maleimide; m is 5; o is 3; and n is 3.

In one embodiment, the compound is general formula IIa



or general formula IIb



where each of R^1, R^2, R^5, and R^6 is the same or different and is independently selected from the group consisting of an aliphatic, heteroaliphatic, sulfoalkyl group, heteroaliphatic with terminal SO_3, a PEG group P—Z where P is selected from an ethylene glycol group, a diethylene glycol group, and a polyethylene glycol group, where the polyethylene glycol group is $(CH_2CH_2O)_s$, where s is an integer from 3-6 inclusive, a sulfonamide group -L-SO_2NH—P—Z, and a carboxamide group -L-CONH—P—Z, and Z is selected from H, a CH_3 group, an alkyl group, a heteroalkyl group, or —CO—NHS; each of R^7, R^8, R^{11}, R^{12}, R^{13}, and R^{14} is the same or different and is independently selected from the group consisting of H, SO_3, a PEG group P—Z where P is selected from an ethylene glycol group, a diethylene glycol group, and a polyethylene glycol group, where the polyethylene glycol group is $(CH_2CH_2O)_s$, where s is an integer from 3-6 inclusive, a sulfonamide group -L-SO_2NH—P—Z, and a carboxamide group -L-CONH—P—Z, and Z is selected from H, a CH_3 group, an alkyl group, or a heteroalkyl group; X is selected from the group consisting of —OH, —SH, —NH_2, —NH—NH_2, —F, —Cl, —Br, I, —NHS hydroxysuccinimidyl/sulfosuccinimidyl), —O-TFP (2,3,5,6-tetrafluorophenoxy), —O-STP (4-sulfo-2,3,5,6-tetrafluorophenoxy), —O-benzotriazole, -benzotriazole, —NR-L-OH, —NR-L-O-phosphoramidite, —NR-L-SH, —NR-L-NH_2, —NR-L-NH—NH_2, —NR-L-CO_2H, —NR-L-CO—NHS, —NR-L-CO-STP, —NR-L-CO-TFP, —NR-L-CO-benzotriazole, —NR-L-CHO, —NR-L-maleimide, —NR-L-NH—CO—CH_2—I, imidazole, azide, —NR-L-O—NH2, and —NR-L-O—CO—NHS, where R is —H or an aliphatic or heteroaliphatic group, and L is selected from the group consisting of a divalent linear (—$(CH_2)_t$—, t=0 to 15), crossed, or cyclic alkyl group optionally substituted by at least one oxygen atom and/or sulfur atom; Kat is a number of Na^+, K^+, Ca^{2+}, ammonia, or other cation(s) needed to compensate the negative charge brought by the cyanine; m is an integer from 0 to 5 inclusive; o is an integer from 0 to 12 inclusive; and n is an integer from 1 to 3 inclusive.

In one embodiment, the compound is general formulas IIa or IIb, collectively general formula II, where each of R1, R5, and R6 is methyl and R2 is a PEG group; each of R7, R8, R11, and R12 is H; each of R13 and R14 is sulfo; X is —OH, —NHS, —O-TFP, or —NR-L-maleimide; m is 0; o is 3; and n is 1. In one embodiment, the compound is general formula II, where each of R1, R5, and R6 is methyl and R2 is a PEG group; each of R7, R8, R11, and R12 is H; each of R13 and R14 is sulfo; X is —OH, —NHS, —O-TFP, or —NR-L-maleimide; m is 1; o is 3; and n is 1. In one embodiment, the compound is general formula II, where each of R1, R5, and R6 is methyl and R2 is a PEG group; each of R7, R8, R11, and R12 is H; each of R13 and R14 is sulfo; X is —OH, —NHS, —O-TFP, or —NR-L-maleimide; m is 2; o is 3; and n is 1. In one embodiment, the compound is general formula II, where each of R1, R5, and R6 is methyl and R2 is a PEG group; each of R7, R8, R11, and R12 is H; each of R13 and R14 is sulfo; X is —OH, —NHS, —O-TFP, or —NR-L-maleimide; m is 3; o is 3; and n is 1. In one embodiment, the compound is general formula II, where each of R1, R5, and R6 is methyl and R2 is a PEG group; each of R7, R8, R11, and R12 is H; each of R13 and R14 is sulfo; X is —OH, —NHS, —O-TFP, or —NR-L-maleimide; m is 4; o is 3; and n is 1. In one embodiment, the compound is general formula II, where each of R1, R5, and R6 is methyl and R2 is a PEG group; each of R7, R8, R11, and R12 is H; each of R13 and R14 is sulfo; X is —OH, —NHS, —O-TFP, or —NR-L-maleimide; m is 5; o is 3; and n is 1.

In one embodiment, the compound is general formula II, where each of R1, R5, and R6 is methyl and R2 is a PEG group; each of R7, R8, R11, and R12 is H; each of R13 and R14 is sulfo; X is —OH, —NHS, —O-TFP, or —NR-L-maleimide; m is 0; o is 3; and n is 2. In one embodiment, the compound is general formula II, where each of R1, R5, and R6 is methyl and R2 is a PEG group; each of R7, R8, R11, and R12 is H; each of R13 and R14 is sulfo; X is —OH, —NHS, —O-TFP, or —NR-L-maleimide; m is 1; o is 3; and n is 2. In one embodiment, the compound is general formula II, where each of R1, R5, and R6 is methyl and R2 is a PEG group; each of R7, R8, R11, and R12 is H; each of R13 and R14 is sulfo; X is —OH, —NHS, —O-TFP, or —NR-L-maleimide; m is 2; o is 3; and n is 2. In one embodiment, the compound is general formula II, where each of R1, R5, and R6 is methyl and R2 is a PEG group; each of R7, R8, R11, and R12 is H; each of R13 and R14 is sulfo; X is —OH, —NHS, —O-TFP, or —NR-L-maleimide; m is 3; o is 3; and n is 2. In one embodiment, the compound is general formula II, where each of R1, R5, and R6 is methyl and R2 is a PEG group; each of R7, R8, R11, and R12 is H; each of R13 and R14 is sulfo; X is —OH, —NHS, —O-TFP, or —NR-L-maleimide; m is 4; o is 3; and n is 2. In one embodiment, the compound is general formula II, where each of R1, R5, and R6 is methyl and R2 is a PEG group; each

of R7, R8, R11, and R12 is H; each of R13 and R14 is sulfo; X is —OH, —NHS, —O-TFP, or —NR-L-maleimide; m is 5; o is 3; and n is 2.

In one embodiment, the compound is general formula II, where each of R1, R5, and R6 is methyl and R2 is a PEG group; each of R7, R8, R11, and R12 is H; each of R13 and R14 is sulfo; X is —OH, —NHS, —O-TFP, or —NR-L-maleimide; m is 0; o is 3; and n is 3. In one embodiment, the compound is general formula II, where each of R1, R5, and R6 is methyl and R2 is a PEG group; each of R7, R8, R11, and R12 is H; each of R13 and R14 is sulfo; X is —OH, —NHS, —O-TFP, or —NR-L-maleimide; m is 1; o is 3; and n is 3. In one embodiment, the compound is general formula II, where each of R1, R5, and R6 is methyl and R2 is a PEG group; each of R7, R8, R11, and R12 is H; each of R13 and R14 is sulfo; X is —OH, —NHS, —O-TFP, or —NR-L-maleimide; m is 2; o is 3; and n is 3. In one embodiment, the compound is general formula II, where each of R1, R5, and R6 is methyl and R2 is a PEG group; each of R7, R8, R11, and R12 is H; each of R13 and R14 is sulfo; X is —OH, —NHS, —O-TFP, or —NR-L-maleimide; m is 3; o is 3; and n is 3. In one embodiment, the compound is general formula II, where each of R1, R5, and R6 is methyl and R2 is a PEG group; each of R7, R8, R11, and R12 is H; each of R13 and R14 is sulfo; X is —OH, —NHS, —O-TFP, or —NR-L-maleimide; m is 4; o is 3; and n is 3. In one embodiment, the compound is general formula II, where each of R1, R5, and R6 is methyl and R2 is a PEG group; each of R7, R8, R11, and R12 is H; each of R13 and R14 is sulfo; X is —OH, —NHS, —O-TFP, or —NR-L-maleimide; m is 5; o is 3; and n is 3.

In one embodiment, the compound is general formula II, where each of R5 and R6 is methyl; each of R1 and R2 is a PEG group; each of R7, R8, R11, and R12 is H; each of R13 and R14 is sulfo; X is —OH, —NHS, —O-TFP, or —NR-L-maleimide; m is 0; o is 3; and n is 1. In one embodiment, the compound is general formula II, where each of R5 and R6 is methyl; each of R1 and R2 is a PEG group; each of R7, R8, R11, and R12 is H; each of R13 and R14 is sulfo; X is —OH, —NHS, —O-TFP, or —NR-L-maleimide; m is 1; o is 3; and n is 1. In one embodiment, the compound is general formula II, where each of R5 and R6 is methyl; each of R1 and R2 is a PEG group; each of R7, R8, R11, and R12 is H; each of R13 and R14 is sulfo; X is —OH, —NHS, —O-TFP, or —NR-L-maleimide; m is 2; o is 3; and n is 1. In one embodiment, the compound is general formula II, where each of R5 and R6 is methyl; each of R1 and R2 is a PEG group; each of R7, R8, R11, and R12 is H; each of R13 and R14 is sulfo; X is —OH, —NHS, —O-TFP, or —NR-L-maleimide; m is 3; o is 3; and n is 1. In one embodiment, the compound is general formula II, where each of R5 and R6 is methyl; each of R1 and R2 is a PEG group; each of R7, R8, R11, and R12 is H; each of R13 and R14 is sulfo; X is —OH, —NHS, —O-TFP, or —NR-L-maleimide; m is 4; o is 3; and n is 1. In one embodiment, the compound is general formula II, where each of R5 and R6 is methyl; each of R1 and R2 is a PEG group; each of R7, R8, R11, and R12 is H; each of R13 and R14 is sulfo; X is —OH, —NHS, —O-TFP, or —NR-L-maleimide; m is 5; o is 3; and n is 1.

In one embodiment, the compound is general formula II, where each of R5 and R6 is methyl; each of R1 and R2 is a PEG group; each of R7, R8, R11, and R12 is H; each of R13 and R14 is sulfo; X is —OH, —NHS, —O-TFP, or —NR-L-maleimide; m is 0; o is 3; and n is 2. In one embodiment, the compound is general formula II, where each of R5 and R6 is methyl; each of R1 and R2 is a PEG group; each of R7, R8, R11, and R12 is H; each of R13 and R14 is sulfo; X is —OH, —NHS, —O-TFP, or —NR-L-maleimide; m is 1; o is 3; and n is 2. In one embodiment, the compound is general formula II, where each of R5 and R6 is methyl; each of R1 and R2 is a PEG group; each of R7, R8, R11, and R12 is H; each of R13 and R14 is sulfo; X is —OH, —NHS, —O-TFP, or —NR-L-maleimide; m is 2; o is 3; and n is 2. In one embodiment, the compound is general formula II, where each of R5 and R6 is methyl; each of R1 and R2 is a PEG group; each of R7, R8, R11, and R12 is H; each of R13 and R14 is sulfo; X is —OH, —NHS, —O-TFP, or —NR-L-maleimide; m is 3; o is 3; and n is 2. In one embodiment, the compound is general formula II, where each of R5 and R6 is methyl; each of R1 and R2 is a PEG group; each of R7, R8, R11, and R12 is H; each of R13 and R14 is sulfo; X is —OH, —NHS, —O-TFP, or —NR-L-maleimide; m is 4; o is 3; and n is 2. In one embodiment, the compound is general formula II, where each of R5 and R6 is methyl; each of R1 and R2 is a PEG group; each of R7, R8, R11, and R12 is H; each of R13 and R14 is sulfo; X4 is —OH, —NHS, —O-TFP, or —NR-L-maleimide; m is 5; o is 3; and n is 2.

In one embodiment, the compound is general formula II, where each of R5 and R6 is methyl; each of R1 and R2 is a PEG group; each of R7, R8, R11, and R12 is H; each of R13 and R14 is sulfo; X is —OH, —NHS, —O-TFP, or —NR-L-maleimide; m is 0; o is 3; and n is 3. In one embodiment, the compound is general formula II, where each of R5 and R6 is methyl; each of R1 and R2 is a PEG group; each of R7, R8, R11, and R12 is H; each of R13 and R14 is sulfo; X is —OH, —NHS, —O-TFP, or —NR-L-maleimide; m is 1; o is 3; and n is 3. In one embodiment, the compound is general formula II, where each of R5 and R6 is methyl; each of R1 and R2 is a PEG group; each of R7, R8, R11, and R12 is H; each of R13 and R14 is sulfo; X is —OH, —NHS, —O-TFP, or —NR-L-maleimide; m is 2; o is 3; and n is 3. In one embodiment, the compound is general formula II, where each of R5 and R6 is methyl; each of R1 and R2 is a PEG group; each of R7, R8, R11, and R12 is H; each of R13 and R14 is sulfo; X is —OH, —NHS, —O-TFP, or —NR-L-maleimide; m is 3; o is 3; and n is 3. In one embodiment, the compound is general formula II, where each of R5 and R6 is methyl; each of R1 and R2 is a PEG group; each of R7, R8, R11, and R12 is H; each of R13 and R14 is sulfo; X is —OH, —NHS, —O-TFP, or —NR-L-maleimide; m is 4; o is 3; and n is 3. In one embodiment, the compound is general formula II, where each of R5 and R6 is methyl; each of R1 and R2 is a PEG group; each of R7, R8, R11, and R12 is H; each of R13 and R14 is sulfo; X is —OH, —NHS, —O-TFP, or —NR-L-maleimide; m is 5; o is 3; and n is 3.

In one embodiment, the compound is general formula II, where each of R5 and R6 is methyl; each of R1 and R2 is a PEG group; each of R7, R8, R11, and R12 is sulfo; each of R13 and R14 is H; X is —OH, —NHS, —O-TFP, or —NR-L-maleimide; m is 0; o is 3; and n is 1. In one embodiment, the compound is general formula II, where each of R5 and R6 is methyl; each of R1 and R2 is a PEG group; each of R7, R8, R11, and R12 is sulfo; each of R13 and R14 is H; X is —OH, —NHS, —O-TFP, or —NR-L-maleimide; m is 1; o is 3; and n is 1. In one embodiment, the compound is general formula II, where each of R5 and R6 is methyl; each of R1 and R2 is a PEG group; each of R7, R8, R11, and R12 is sulfo; each of R13 and R14 is H; X is —OH, —NHS, —O-TFP, or —NR-L-maleimide; m is 2; o is 3; and n is 1. In one embodiment, the compound is general formula II, where each of R5 and R6 is methyl; each of R1 and R2 is a PEG group; each of R7, R8, R11, and R12 is sulfo; each of R13 and R14 is H; X is —OH, —NHS, —O-TFP, or —NR-L-maleimide; m is 3; o is 3; and n is 1. In one embodiment, the compound is general formula II, where each of R5 and R6 is methyl; each of R1 and R2 is

a PEG group; each of R7, R8, R11, and R12 is sulfo; each of R13 and R14 is H; X is —OH, —NHS, —O-TFP, or —NR-L-maleimide; m is 4; o is 3; and n is 1. In one embodiment, the compound is general formula II, where each of R5 and R6 is methyl; each of R1 and R2 is a PEG group; each of R7, R8, R11, and R12 is sulfo; each of R13 and R14 is H; X is —OH, —NHS, —O-TFP, or —NR-L-maleimide; m is 5; o is 3; and n is 1.

In one embodiment, the compound is general formula II, where each of R5 and R6 is methyl; each of R1 and R2 is a PEG group; each of R7, R8, R11, and R12 is sulfo; each of R13 and R14 is H; X is —OH, —NHS, —O-TFP, or —NR-L-maleimide; m is 0; o is 3; and n is 2. In one embodiment, the compound is general formula II, where each of R5 and R6 is methyl; each of R1 and R2 is a PEG group; each of R7, R8, R11, and R12 is sulfo; each of R13 and R14 is H; X is —OH, —NHS, —O-TFP, or —NR-L-maleimide; m is 1; o is 3; and n is 2. In one embodiment, the compound is general formula II, where each of R5 and R6 is methyl; each of R1 and R2 is a PEG group; each of R7, R8, R11, and R12 is sulfo; each of R13 and R14 is H; X is —OH, —NHS, —O-TFP, or —NR-L-maleimide; m is 2; o is 3; and n is 2. In one embodiment, the compound is general formula II, where each of R5 and R6 is methyl; each of R1 and R2 is a PEG group; each of R7, R8, R11, and R12 is sulfo; each of R13 and R14 is H; X is —OH, —NHS, —O-TFP, or —NR-L-maleimide; m is 3; o is 3; and n is 2. In one embodiment, the compound is general formula II, where each of R5 and R6 is methyl; each of R1 and R2 is a PEG group; each of R7, R8, R11, and R12 is sulfo; each of R13 and R14 is H; X is —OH, —NHS, —O-TFP, or —NR-L-maleimide; m is 4; o is 3; and n is 2. In one embodiment, the compound is general formula II, where each of R5 and R6 is methyl; each of R1 and R2 is a PEG group; each of R7, R8, R11, and R12 is sulfo; each of R13 and R14 is H; X is —OH, —NHS, —O-TFP, or —NR-L-maleimide; m is 5; o is 3; and n is 2.

In one embodiment, the compound is general formula II, where each of R5 and R6 is methyl; each of R1 and R2 is a PEG group; each of R7, R8, R11, and R12 is sulfo; each of R13 and R14 is H; X is —OH, —NHS, —O-TFP, or —NR-L-maleimide; m is 0; o is 3; and n is 3. In one embodiment, the compound is general formula II, where each of R5 and R6 is methyl; each of R1 and R2 is a PEG group; each of R7, R8, R11, and R12 is sulfo; each of R13 and R14 is H; X is —OH, —NHS, —O-TFP, or —NR-L-maleimide; m is 1; o is 3; and n is 3. In one embodiment, the compound is general formula II, where each of R5 and R6 is methyl; each of R1 and R2 is a PEG group; each of R7, R8, R11, and R12 is sulfo; each of R13 and R14 is H; X is —OH, —NHS, —O-TFP, or —NR-L-maleimide; m is 2; o is 3; and n is 3. In one embodiment, the compound is general formula II, where each of R5 and R6 is methyl; each of R1 and R2 is a PEG group; each of R7, R8, R11, and R12 is sulfo; each of R13 and R14 is H; X is —OH, —NHS, —O-TFP, or —NR-L-maleimide; m is 3; o is 3; and n is 3. In one embodiment, the compound is general formula II, where each of R5 and R6 is methyl; each of R1 and R2 is a PEG group; each of R7, R8, R11, and R12 is sulfo; each of R13 and R14 is H; X is —OH, —NHS, —O-TFP, or —NR-L-maleimide; m is 4; o is 3; and n is 3. In one embodiment, the compound is general formula II, where each of R5 and R6 is methyl; each of R1 and R2 is a PEG group; each of R7, R8, R11, and R12 is sulfo; each of R13 and R14 is H; X is —OH, —NHS, —O-TFP, or —NR-L-maleimide; m is 5; o is 3; and n is 3.

In one embodiment, the compound is general formula II, where each of R5 and R6 is methyl; each of R1 and R2 is a PEG group; each of R7 and R8 is sulfo; each of R11 and R12 is a sulfonamide group —SO_2NH—P where P is a PEG group; each of R13 and R14 is H; X is —OH, —NHS, —O-TFP, or —NR-L-maleimide; m is 0; o is 3; and n is 1. In one embodiment, the compound is general formula II, where each of R5 and R6 is methyl; each of R1 and R2 is a PEG group; each of R7 and R8 is sulfo; each of R11 and R12 is a sulfonamide group —SO_2NH—P where P is a PEG group; each of R13 and R14 is H; X is —OH, —NHS, —O-TFP, or —NR-L-maleimide; m is 1; o is 3; and n is 1. In one embodiment, the compound is general formula II, where each of R5 and R6 is methyl; each of R1 and R2 is a PEG group; each of R7 and R8 is sulfo; each of R11 and R12 is a sulfonamide group —SO_2NH—P where P is a PEG group; each of R13 and R14 is H; X is —OH, —NHS, —O-TFP, or —NR-L-maleimide; m is 2; o is 3; and n is 1. In one embodiment, the compound is general formula II, where each of R5 and R6 is methyl; each of R1 and R2 is a PEG group; each of R7 and R8 is sulfo; each of R11 and R12 is a sulfonamide group —SO_2NH—P where P is a PEG group; each of R13 and R14 is H; X is —OH, —NHS, —O-TFP, or —NR-L-maleimide; m is 3; o is 3; and n is 1. In one embodiment, the compound is general formula II, where each of R5 and R6 is methyl; each of R1 and R2 is a PEG group; each of R7 and R8 is sulfo; each of R11 and R12 is a sulfonamide group —SO_2NH—P where P is a PEG group; each of R13 and R14 is H; X is —OH, —NHS, —O-TFP, or —NR-L-maleimide; m is 4; o is 3; and n is 1. In one embodiment, the compound is general formula II, where each of R5 and R6 is methyl; each of R1 and R2 is a PEG group; each of R7 and R8 is sulfo; each of R11 and R12 is a sulfonamide group —SO_2NH—P where P is a PEG group; each of R13 and R14 is H; X is —OH, —NHS, —O-TFP, or —NR-L-maleimide; m is 5; o is 3; and n is 1.

In one embodiment, the compound is general formula II, where each of R5 and R6 is methyl; each of R1 and R2 is a PEG group; each of R7 and R8 is sulfo; each of R11 and R12 is a sulfonamide group —SO_2NH—P where P is a PEG group; each of R13 and R14 is H; X is —OH, —NHS, —O-TFP, or —NR-L-maleimide; m is 0; o is 3; and n is 2. In one embodiment, the compound is general formula II, where each of R5 and R6 is methyl; each of R1 and R2 is a PEG group; each of R7 and R8 is sulfo; each of R11 and R12 is a sulfonamide group —SO_2NH—P where P is a PEG group; each of R13 and R14 is H; X is —OH, —NHS, —O-TFP, or —NR-L-maleimide; m is 1; o is 3; and n is 2. In one embodiment, the compound is general formula II, where each of R5 and R6 is methyl; each of R1 and R2 is a PEG group; each of R7 and R8 is sulfo; each of R11 and R12 is a sulfonamide group —SO_2NH—P where P is a PEG group; each of R13 and R14 is H; X is —OH, —NHS, —O-TFP, or —NR-L-maleimide; m is 2; o is 3; and n is 2. In one embodiment, the compound is general formula II, where each of R5 and R6 is methyl; each of R1 and R2 is a PEG group; each of R7 and R8 is sulfo; each of R11 and R12 is a sulfonamide group —SO_2NH—P where P is a PEG group; each of R13 and R14 is H; X is —OH, —NHS, —O-TFP, or —NR-L-maleimide; m is 3; o is 3; and n is 2. In one embodiment, the compound is general formula II, where each of R5 and R6 is methyl; each of R1 and R2 is a PEG group; each of R7 and R8 is sulfo; each of R11 and R12 is a sulfonamide group —SO_2NH—P where P is a PEG group; each of R13 and R14 is H; X is —OH, —NHS, —O-TFP, or —NR-L-maleimide; m is 4; o is 3; and n is 2. In one embodiment, the compound is general formula II, where each of R5 and R6 is methyl; each of R1 and R2 is a PEG group; each of R7 and R8 is sulfo; each of R11 and R12 is a sulfonamide group —SO_2NH—P where P is a PEG group; each of R13 and R14 is H; X is —OH, —NHS, —O-TFP, or —NR-L-maleimide; m is 5; o is 3; and n is 2.

In one embodiment, the compound is general formula II, where each of R5 and R6 is methyl; each of R1 and R2 is a PEG group; each of R7 and R8 is sulfo; each of R11 and R12 is a sulfonamide group —SO_2NH—P where P is a PEG group; each of R13 and R14 is H; X is —OH, —NHS, —O-TFP, or —NR-L-maleimide; m is 0; o is 3; and n is 3. In one embodiment, the compound is general formula II, where each of R5 and R6 is methyl; each of R1 and R2 is a PEG group; each of R7 and R8 is sulfo; each of R11 and R12 is a sulfonamide group —SO_2NH—P where P is a PEG group; each of R13 and R14 is H; X is —OH, —NHS, —O-TFP, or —NR-L-maleimide; m is 1; o is 3; and n is 3. In one embodiment, the compound is general formula II, where each of R5 and R6 is methyl; each of R1 and R2 is a PEG group; each of R7 and R8 is sulfo; each of R11 and R12 is a sulfonamide group —SO_2NH—P where P is a PEG group; each of R13 and R14 is H; X is —OH, —NHS, —O-TFP, or —NR-L-maleimide; m is 2; o is 3; and n is 3. In one embodiment, the compound is general formula II, where each of R5 and R6 is methyl; each of R1 and R2 is a PEG group; each of R7 and R8 is sulfo; each of R11 and R12 is a sulfonamide group —SO_2NH—P where P is a PEG group; each of R13 and R14 is H; X is —OH, —NHS, —O-TFP, or —NR-L-maleimide; m is 3; o is 3; and n is 3. In one embodiment, the compound is general formula II, where each of R5 and R6 is methyl; each of R1 and R2 is a PEG group; each of R7 and R8 is sulfo; each of R11 and R12 is a sulfonamide group —SO_2NH—P where P is a PEG group; each of R13 and R14 is H; X is —OH, —NHS, —O-TFP, or —NR-L-maleimide; m is 4; o is 3; and n is 3. In one embodiment, the compound is general formula II, where each of R5 and R6 is methyl; each of R1 and R2 is a PEG group; each of R7 and R8 is sulfo; each of R11 and R12 is a sulfonamide group —SO_2NH—P where P is a PEG group; each of R13 and R14 is H; X is —OH, —NHS, —O-TFP, or —NR-L-maleimide; m is 5; o is 3; and n is 3.

In one embodiment, the compound is general formula II, where each of R5 and R6 is methyl; each of R1 and R2 is a PEG group; each of R7 and R8 is sulfo; each of R11 and R12 is a carboxamide group —CONH—P where P is a PEG group; each of R13 and R14 is H; X is —OH, —NHS, —O-TFP, or —NR-L-maleimide; m is 0; o is 3; and n is 1. In one embodiment, the compound is general formula II, where each of R5 and R6 is methyl; each of R1 and R2 is a PEG group; each of R7 and R8 is sulfo; each of R11 and R12 is a carboxamide group —CONH—P where P is a PEG group; each of R13 and R14 is H; X is —OH, —NHS, —O-TFP, or —NR-L-maleimide; m is 1; o is 3; and n is 1. In one embodiment, the compound is general formula II, where each of R5 and R6 is methyl; each of R1 and R2 is a PEG group; each of R7 and R8 is sulfo; each of R11 and R12 is a carboxamide group —CONH—P where P is a PEG group; each of R13 and R14 is H; X is —OH, —NHS, —O-TFP, or —NR-L-maleimide; m is 2; o is 3; and n is 1. In one embodiment, the compound is general formula II, where each of R5 and R6 is methyl; each of R1 and R2 is a PEG group; each of R7 and R8 is sulfo; each of R11 and R12 is a carboxamide group —CONH—P where P is a PEG group; each of R13 and R14 is H; X is —OH, —NHS, —O-TFP, or —NR-L-maleimide; m is 3; o is 3; and n is 1. In one embodiment, the compound is general formula II, where each of R5 and R6 is methyl; each of R1 and R2 is a PEG group; each of R7 and R8 is sulfo; each of R11 and R12 is a carboxamide group —CONH—P where P is a PEG group; each of R13 and R14 is H; X is —OH, —NHS, —O-TFP, or —NR-L-maleimide; m is 4; o is 3; and n is 1. In one embodiment, the compound is general formula II, where each of R5 and R6 is methyl; each of R1 and R2 is a PEG group; each of R7 and R8 is sulfo; each of R11 and R12 is a carboxamide group —CONH—P where P is a PEG group; each of R13 and R14 is H; X is —OH, —NHS, —O-TFP, or —NR-L-maleimide; m is 5; o is 3; and n is 1.

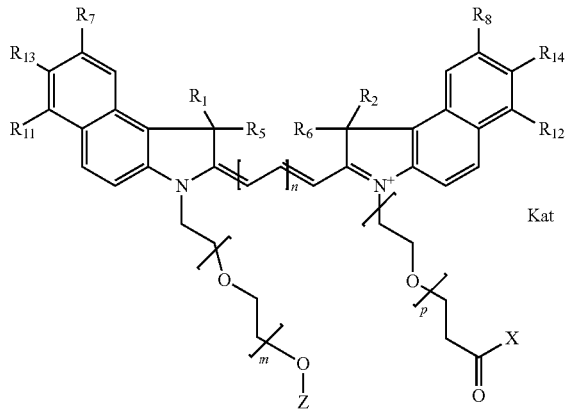
In one embodiment, the compound is general formula II, where each of R5 and R6 is methyl; each of R1 and R2 is a PEG group; each of R7 and R8 is sulfo; each of R11 and R12 is a carboxamide group —CONH—P where P is a PEG group; each of R13 and R14 is H; X is —OH, —NHS, —O-TFP, or —NR-L-maleimide; m is 0; o is 3; and n is 2. In one embodiment, the compound is general formula II, where each of R5 and R6 is methyl; each of R1 and R2 is a PEG group; each of R7 and R8 is sulfo; each of R11 and R12 is a carboxamide group —CONH—P where P is a PEG group; each of R13 and R14 is H; X is —OH, —NHS, —O-TFP, or —NR-L-maleimide; m is 1; o is 3; and n is 2. In one embodiment, the compound is general formula II, where each of R5 and R6 is methyl; each of R1 and R2 is a PEG group; each of R7 and R8 is sulfo; each of R11 and R12 is a carboxamide group —CONH—P where P is a PEG group; each of R13 and R14 is H; X is —OH, —NHS, —O-TFP, or —NR-L-maleimide; m is 2; o is 3; and n is 2. In one embodiment, the compound is general formula II, where each of R5 and R6 is methyl; each of R1 and R2 is a PEG group; each of R7 and R8 is sulfo; each of R11 and R12 is a carboxamide group —CONH—P where P is a PEG group; each of R13 and R14 is H; X is —OH, —NHS, —O-TFP, or —NR-L-maleimide; m is 3; o is 3; and n is 2. In one embodiment, the compound is general formula II, where each of R5 and R6 is methyl; each of R1 and R2 is a PEG group; each of R7 and R8 is sulfo; each of R11 and R12 is a carboxamide group —CONH—P where P is a PEG group; each of R13 and R14 is H; X is —OH, —NHS, —O-TFP, or —NR-L-maleimide; m is 4; o is 3; and n is 2. In one embodiment, the compound is general formula II, where each of R5 and R6 is methyl; each of R1 and R2 is a PEG group; each of R7 and R8 is sulfo; each of R11 and R12 is a carboxamide group —CONH—P where P is a PEG group; each of R13 and R14 is H; X is —OH, —NHS, —O-TFP, or —NR-L-maleimide; m is 5; o is 3; and n is 2.

In one embodiment, the compound is general formula II, where each of R5 and R6 is methyl; each of R1 and R2 is a PEG group; each of R7 and R8 is sulfo; each of R11 and R12 is a carboxamide group —CONH—P where P is a PEG group; each of R13 and R14 is H; X is —OH, —NHS, —O-TFP, or —NR-L-maleimide; m is 0; o is 3; and n is 3. In one embodiment, the compound is general formula II, where each of R5 and R6 is methyl; each of R1 and R2 is a PEG group; each of R7 and R8 is sulfo; each of R11 and R12 is a carboxamide group —CONH—P where P is a PEG group; each of R13 and R14 is H; X is —OH, —NHS, —O-TFP, or —NR-L-maleimide; m is 1; o is 3; and n is 3. In one embodiment, the compound is general formula II, where each of R5 and R6 is methyl; each of R1 and R2 is a PEG group; each of R7 and R8 is sulfo; each of R11 and R12 is a carboxamide group —CONH—P where P is a PEG group; each of R13 and R14 is H; X is —OH, —NHS, —O-TFP, or —NR-L-maleimide; m is 2; o is 3; and n is 3. In one embodiment, the compound is general formula II, where each of R5 and R6 is methyl; each of R1 and R2 is a PEG group; each of R7 and R8 is sulfo; each of R11 and R12 is a carboxamide group —CONH—P where P is a PEG group; each of R13 and R14 is H; X is —OH, —NHS, —O-TFP, or —NR-L-maleimide; m is 3; o is 3; and n is 3. In one embodiment, the compound is general formula II, where each of R5 and R6 is methyl; each of R1 and R2 is a PEG group; each of R7 and R8 is sulfo; each of R11 and R12 is a carboxamide group —CONH—P where P is a PEG group; each of R13 and R14 is H; X is —OH, —NHS, —O-TFP, or —NR-L-maleimide; m is 4; o is 3; and n is 3. In one embodiment, the compound is general formula II, where each of R5 and R6 is methyl; each of R1 and R2 is a PEG group; each of R7 and R8 is sulfo; each of R11 and R12 is a carboxamide group —CONH—P where P is a PEG group; each of R13 and R14 is H; X is —OH, —NHS, —O-TFP, or —NR-L-maleimide; m is 5; o is 3; and n is 3. In one embodiment, the compound is general formula II, where each of R5 and R6 is methyl; each of R1 and R2 is a PEG group; each of R7 and R8 is sulfo; each of R11 and R12 is a carboxamide group —CONH—P where P is a PEG group; each of R13 and R14 is H; X is —OH, —NHS, —O-TFP, or —NR-L-maleimide; m is 0; o is 3; and n is 2. In one embodiment, the compound is general formula II, where each of R5 and R6 is methyl; each of R1 and R2 is a PEG group; each of R7 and R8 is sulfo; each of R11 and R12 is a carboxamide group —CONH—P where P is a PEG group; each of R13 and R14 is H; X is —OH, —NHS, —O-TFP, or —NR-L-maleimide; m is 1; o is 3; and n is 2. In one embodiment, the compound is general formula II, where each of R5 and R6 is methyl; each of R1 and R2 is a PEG group; each of R7 and R8 is sulfo; each of R11 and R12 is a carboxamide group —CONH—P where P is a PEG group; each of R13 and R14 is H; X is —OH, —NHS, —O-TFP, or —NR-L-maleimide; m is 2; o is 3; and n is 2. In one embodiment, the compound is general formula II, where each of R5 and R6 is methyl; each of R1 and R2 is a PEG group; each of R7 and R8 is sulfo; each of R11 and R12 is a carboxamide group —CONH—P where P is a PEG group; each of R13 and R14 is H; X is —OH, —NHS, —O-TFP, or —NR-L-maleimide; m is 3; o is 3; and n is 2. In one embodiment, the compound is general formula II, where each of R5 and R6 is methyl; each of R1 and R2 is a PEG group; each of R7 and R8 is sulfo; each of R11 and R12 is a carboxamide group —CONH—P where P is a PEG group; each of R13 and R14 is H; X is —OH, —NHS, —O-TFP, or —NR-L-maleimide; m is 4; o is 3; and n is 2. In one embodiment, the compound is general formula II, where each of R5 and R6 is methyl; each of R1 and R2 is a PEG group; each of R7 and R8 is sulfo; each of R11 and R12 is a carboxamide group —CONH—P where P is a PEG group; each of R13 and R14 is H; X is —OH, —NHS, —O-TFP, or —NR-L-maleimide; m is 5; o is 3; and n is 2.

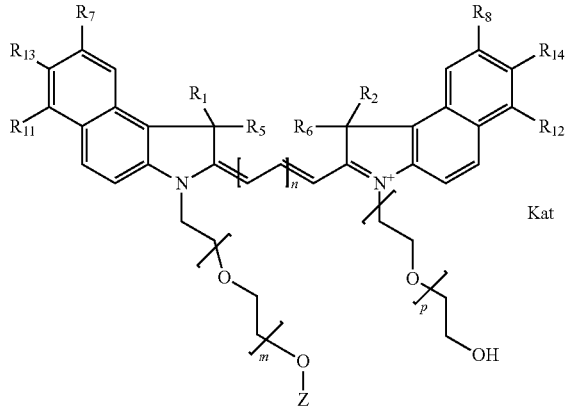
In one embodiment, the compound is general formula II, where each of R5 and R6 is methyl; each of R1 and R2 is a PEG group; each of R7 and R8 is sulfo; each of R11 and R12 is a carboxamide group —CONH—P where P is a PEG group; each of R13 and R14 is H; X is —OH, —NHS, —O-TFP, or —NR-L-maleimide; m is 0; o is 3; and n is 3. In one embodiment, the compound is general formula II, where each of R5 and R6 is methyl; each of R1 and R2 is a PEG group; each of R7 and R8 is sulfo; each of R11 and R12 is a carboxamide group —CONH—P where P is a PEG group; each of R13 and R14 is H; X is —OH, —NHS, —O-TFP, or —NR-L-maleimide; m is 1; o is 3; and n is 3. In one embodiment, the compound is general formula II, where each of R5 and R6 is methyl; each of R1 and R2 is a PEG group; each of R7 and R8 is sulfo; each of R11 and R12 is a carboxamide group —CONH—P where P is a PEG group; each of R13 and R14 is H; X is —OH, —NHS, —O-TFP, or —NR-L-maleimide; m is 2; o is 3; and n is 3. In one embodiment, the compound is general formula II, where each of R5 and R6 is methyl; each of R1 and R2 is a PEG group; each of R7 and R8 is sulfo; each of R11 and R12 is a carboxamide group —CONH—P where P is a PEG group; each of R13 and R14 is H; X is —OH, —NHS, —O-TFP, or —NR-L-maleimide; m is 3; o is 3; and n is 3. In one embodiment, the compound is general formula II, where each of R5 and R6 is methyl; each of R1 and R2 is a PEG group; each of R7 and R8 is sulfo; each of R11 and R12 is a carboxamide group —CONH—P where P is a PEG group; each of R13 and R14 is H; X is —OH, —NHS, —O-TFP, or —NR-L-maleimide; m is 4; o is 3; and n is 3. In one

embodiment, the compound is general formula II, where each of R5 and R6 is methyl; each of R1 and R2 is a PEG group; each of R7 and R8 is sulfo; each of R11 and R12 is a carboxamide group —CONH—P where P is a PEG group; each of R13 and R14 is H; X is —OH, —NHS, —O-TFP, or —NR-L-maleimide; m is 5; o is 3; and n is 3.

In one embodiment, the compound is general formula IIIa



or general formula IIIb



where each of R^1, R^2, R^5, and R^6 is the same or different and is independently selected from the group consisting of an aliphatic, heteroaliphatic, sulfoalkyl group, heteroaliphatic with terminal SO_3, a PEG group P—Z where P is selected from an ethylene glycol group, a diethylene glycol group, and a polyethylene glycol group, where the polyethylene glycol group is $(CH_2CH_2O)_s$, where s is an interger from 3-6 inclusive, a sulfonamide group -L-SO_2NH—P—Z, and a carboxamide group -L-CONH—P—Z, and Z is selected from H, a CH_3 group, an alkyl group, or a heteroalkyl group; each of R^7, R^8, R^{11}, R^{12}, R^{13}, and R^{14} is the same or different and is independently selected from the group consisting of H, SO_3, a PEG group P—Z where P is selected from an ethylene glycol group, a diethylene glycol group, and a polyethylene glycol group, where the polyethylene glycol group is $(CH_2CH_2O)_s$, where s is an interger from 3-6 inclusive, a sulfonamide group —SO_2NH—P—Z, and a carboxamide group —CONH—P—Z, and Z is selected from H, a CH_3 group, an alkyl group, a heteroalkyl group, or —CO—NHS; X is selected from the group consisting of —OH, —SH, —NH_2, —NH—NH_2, —F, —Cl, —Br, I, —NHS hydroxysuccinimidyl/sulfosuccinimidyl), —O-TFP (2,3,5,6-tetrafluorophenoxy), —O-STP (4-sulfo-2,3,5,6-tetrafluorophenoxy), —O-benzotriazole, -benzotriazole, —NR-L-OH, —NR-L-O-phosphoramidite, —NR-L-SH, —NR-L-NH_2, —NR-L-NH—NH_2, —NR-L-CO_2H, —NR-L-CO—NHS, —NR-L-CO-STP, —NR-L-CO-TFP, —NR-L-CO-benzotriazole, —NR-L-CHO, —NR-L-maleimide, —NR-L-NH—CO—CH2-I, imidazole, azide, —NR-L-O—NH2, and —NR-L-O—CO—NHS, where R is —H or an aliphatic or heteroaliphatic group, and L is selected from the group consisting of a divalent linear (—$(CH_2)_t$—, t=0 to 15), crossed, or cyclic alkyl group optionally substituted by at least one oxygen atom and/or sulfur atom; Kat is a number of Na^+, K^+, Ca^{2+}, ammonia, or other cation(s) needed to compensate the negative charge brought by the cyanine; m is an integer from 0 to 5 inclusive; p is an integer from 1 to 6 inclusive; and n is an integer from 1 to 3 inclusive.

In one embodiment, the compound is general formulas IIIa or IIIb, collectively termed general formula III where each of R1, R5, and R6 is methyl; R2 is a PEG group; each of R7, R8, R11, and R12 is H; each of R13 and R14 is sulfo; X is —OH, —NHS, —O-TFP, or —NR-L-maleimide; m is 0; p is 1; and n is 1. In one embodiment, the compound is general formula III where each of R1, R5, and R6 is methyl; R2 is a PEG group; each of R7, R8, R11, and R12 is H; each of R13 and R14 is sulfo; X is —OH, —NHS, —O-TFP, or —NR-L-maleimide; m is 1; p is 2; and n is 1. In one embodiment, the compound is general formula III, where each of R1, R5, and R6 is methyl; R2 is a PEG group; each of R7, R8, R11, and R12 is H; each of R13 and R14 is sulfo; X is —OH, —NHS, —O-TFP, or —NR-L-maleimide; m is 2; p is 3; and n is 1. In one embodiment, the compound is general formula III, where each of R1, R5, and R6 is methyl; R2 is a PEG group; each of R7, R8, R11, and R12 is H; each of R13 and R14 is sulfo; X is —OH, —NHS, —O-TFP, or —NR-L-maleimide; m is 3; p is 4; and n is 1. In one embodiment, the compound is general formula III, where each of R1, R5, and R6 is methyl; R2 is a PEG group; each of R7, R8, R11, and R12 is H; each of R13 and R14 is sulfo; X is —OH, —NHS, —O-TFP, or —NR-L-maleimide; m is 4; p is 5; and n is 1. In one embodiment, the compound is general formula III, where each of R1, R5, and R6 is methyl; R2 is a PEG group; each of R7, R8, R11, and R12 is H; each of R13 and R14 is sulfo; X is —OH, —NHS, —O-TFP, or —NR-L-maleimide; m is 5; p is 6; and n is 1.

In one embodiment, the compound is general formula III, where each of R1, R5, and R6 is methyl; R2 is a PEG group; each of R7, R8, R11, and R12 is H; each of R13 and R14 is sulfo; X is —OH, —NHS, —O-TFP, or —NR-L-maleimide; m is 0; p is 1; and n is 2. In one embodiment, the compound is general formula III, where each of R1, R5, and R6 is methyl; R2 is a PEG group; each of R7, R8, R11, and R12 is H; each of R13 and R14 is sulfo; X is —OH, —NHS, —O-TFP, or —NR-L-maleimide; m is 1; p is 2; and n is 2. In one embodiment, the compound is general formula III, where each of R1, R5, and R6 is methyl; R2 is a PEG group; each of R7, R8, R11, and R12 is H; each of R13 and R14 is sulfo; X is —OH, —NHS, —O-TFP, or —NR-L-maleimide; m is 2; p is 3; and n is 2. In one embodiment, the compound is general formula III, where each of R1, R5, and R6 is methyl; R2 is a PEG group; each of R7, R8, R11, and R12 is H; each of R13 and R14 is sulfo; X is —OH, —NHS, —O-TFP, or —NR-L-maleimide; m is 3; p is 4; and n is 2. In one embodiment, the compound is general formula III, where each of R1, R5, and R6 is methyl; R2 is a PEG group; each of R7, R8, R11, and R12 is H; each of R13 and R14 is sulfo; X is —OH, —NHS, —O-TFP, or —NR-L-maleimide; m is 4; p is 5; and n is 2. In one embodiment, the compound is general formula III, where each of R1, R5, and R6 is methyl; R2 is a PEG group; each of R7, R8, R11, and R12 is H; each of R13 and R14 is sulfo; X is —OH, —NHS, —O-TFP, or —NR-L-maleimide; m is 5; p is 6; and n is 2. In one embodiment, the compound is general formula III, where

each of R1, R5, and R6 is methyl; R2 is a PEG group; each of R7, R8, R11, and R12 is H; each of R13 and R14 is sulfo; X is —OH, —NHS, —O-TFP, or —NR-L-maleimide; m is 5; p is 6; and n is 2.

In one embodiment, the compound is general formula III, where each of R1, R5, and R6 is methyl; R2 is a PEG group; each of R7, R8, R11, and R12 is H; each of R13 and R14 is sulfo; X is —OH, —NHS, —O-TFP, or —NR-L-maleimide; m is 0; p is 1; and n is 3. In one embodiment, the compound is general formula III, where each of R1, R5, and R6 is methyl; R2 is a PEG group; each of R7, R8, R11, and R12 is H; each of R13 and R14 is sulfo; X is —OH, —NHS, —O-TFP, or —NR-L-maleimide; m is 1; p is 2; and n is 3. In one embodiment, the compound is general formula III, where each of R1, R5, and R6 is methyl; R2 is a PEG group; each of R7, R8, R11, and R12 is H; each of R13 and R14 is sulfo; X is —OH, —NHS, —O-TFP, or —NR-L-maleimide; m is 2; p is 3; and n is 3. In one embodiment, the compound is general formula III, where each of R1, R5, and R6 is methyl; R2 is a PEG group; each of R7, R8, R11, and R12 is H; each of R13 and R14 is sulfo; X is —OH, —NHS, —O-TFP, or —NR-L-maleimide; m is 3; p is 4; and n is 3. In one embodiment, the compound is general formula III, where each of R1, R5, and R6 is methyl; R2 is a PEG group; each of R7, R8, R11, and R12 is H; each of R13 and R14 is sulfo; X is —OH, —NHS, —O-TFP, or —NR-L-maleimide; m is 4; p is 5; and n is 3. In one embodiment, the compound is general formula III, where each of R1, R5, and R6 is methyl; R2 is a PEG group; each of R7, R8, R11, and R12 is H; each of R13 and R14 is sulfo; X is —OH, —NHS, —O-TFP, or —NR-L-maleimide; m is 5; p is 6; and n is 3.

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In one embodiment, the compound is general formula III, where each of R5 and R6 is methyl; each of R1 and R2 is a PEG group; each of R7, R8, R11, and R12 is sulfo; each of R13 and R14 is H; X is —OH, —NHS, —O-TFP, or —NR-L-maleimide; m is 0; p is 1; and n is 1. In one embodiment, the compound is general formula III, where each of R5 and R6 is methyl; each of R1 and R2 is a PEG group; each of R7, R8, R11, and R12 is sulfo; each of R13 and R14 is H; X is —OH, —NHS, —O-TFP, or —NR-L-maleimide; m is 1; p is 2; and n is 1. In one embodiment, the compound is general formula III, where each of R5 and R6 is methyl; each of R1 and R2 is a PEG group; each of R7, R8, R11, and R12 is sulfo; each of R13 and R14 is H; X is —OH, —NHS, —O-TFP, or —NR-L-maleimide; m is 2; p is 3; and n is 1. In one embodiment, the compound is general formula III, where each of R5 and R6 is methyl; each of R1 and R2 is a PEG group; each of R7, R8, R11, and R12 is sulfo; each of R13 and R14 is H; X is —OH, —NHS, —O-TFP, or —NR-L-maleimide; m is 3; p is 4; and n is 1. In one embodiment, the compound is general formula III, where each of R5 and R6 is methyl; each of R1 and R2 is a PEG group; each of R7, R8, R11, and R12 is sulfo; each of R13 and R14 is H; X is —OH, —NHS, —O-TFP, or —NR-

L-maleimide; m is 4; p is 5; and n is 1. In one embodiment, the compound is general formula III, where each of R5 and R6 is methyl; each of R1 and R2 is a PEG group; each of R7, R8, R11, and R12 is sulfo; each of R13 and R14 is H; X is —OH, —NHS, —O—. TFP, or —NR-L-maleimide; m is 5; p is 6; and n is 1.

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In one embodiment, the compound is general formula III, where each of R5 and R6 is methyl; each of R1 and R2 is a PEG group; each of R7, R8, R11, and R12 is H; each of R13 and R14 is sulfo; X is —OH, —NHS, —O-TFP, or —NR-L-maleimide; m is 0; p is 1; and n is 2. In one embodiment, the compound is general formula III, where each of R5 and R6 is methyl; each of R1 and R2 is a PEG group; each of R7, R8, R11, and R12 is H; each of R13 and R14 is sulfo; X is —OH, —NHS, —O-TFP, or —NR-L-maleimide; m is 1; p is 2; and n is 2. In one embodiment, the compound is general formula III, where each of R5 and R6 is methyl; each of R1 and R2 is a PEG group; each of R7, R8, R11, and R12 is H; each of R13 and R14 is sulfo; X is —OH, —NHS, —O-TFP, or —NR-L-maleimide; m is 2; p is 3; and n is 2. In one embodiment, the compound is general formula III, where each of R5 and R6 is methyl; each of R1 and R2 is a PEG group; each of R7, R8, R11, and R12 is H; each of R13 and R14 is sulfo; X is —OH, —NHS, —O-TFP, or —NR-L-maleimide; m is 3; p is 4; and n is 2. In one embodiment, the compound is general formula III, where each of R5 and R6 is methyl; each of R1 and R2 is a PEG group; each of R7, R8, R11, and R12 is H; each of R13 and R14 is sulfo; X is —OH, —NHS, —O-TFP, or —NR-L-maleimide; m is 4; p is 5; and n is 2. In one embodiment, the compound is general formula III, where each of R5 and R6 is methyl; each of R1 and R2 is a PEG group; each of R7, R8, R11, and R12 is H; each of R13 and R14 is sulfo; X is —OH, —NHS, —O-TFP, or —NR-L-maleimide; m is 5; p is 6; and n is 2.

In one embodiment, the compound is general formula III, where each of R5 and R6 is methyl; each of R1 and R2 is a PEG group; each of R7, R8, R11, and R12 is H; each of R13 and R14 is sulfo; X is —OH, —NHS, —O-TFP, or —NR-L-maleimide; m is 0; p is 1; and n is 3. In one embodiment, the compound is general formula III, where each of R5 and R6 is methyl; each of R1 and R2 is a PEG group; each of R7, R8, R11, and R12 is H; each of R13 and R14 is sulfo; X is —OH, —NHS, —O-TFP, or —NR-L-maleimide; m is 1; p is 2; and n is 3. In one embodiment, the compound is general formula III, where each of R5 and R6 is methyl; each of R1 and R2 is a PEG group; each of R7, R8, R11, and R12 is H; each of R13 and R14 is sulfo; X is —OH, —NHS, —O-TFP, or —NR-L-maleimide; m is 2; p is 3; and n is 3. In one embodiment, the compound is general formula III, where each of R5 and R6 is methyl; each of R1 and R2 is a PEG group; each of R7, R8, R11, and R12 is H; each of R13 and R14 is sulfo; X is —OH, —NHS, —O-TFP, or —NR-L-maleimide; m is 3; p is 4; and n is 3. In one embodiment, the compound is general formula III, where each of R5 and R6 is methyl; each of R1 and R2 is a PEG group; each of R7, R8, R11, and R12 is H; each of R13 and R14 is sulfo; X is —OH, —NHS, —O-TFP, or —NR-L-maleimide; m is 4; p is 5; and n is 3. In one embodiment, the compound is general formula III, where each of R5 and R6 is methyl; each of R1 and R2 is a PEG group; each of R7, R8, R11, and R12 is H; each of R13 and R14 is sulfo; X is —OH, —NHS, —O-TFP, or —NR-L-maleimide; m is 5; p is 6; and n is 3.

In one embodiment, the compound is general formula III, where each of R5 and R6 is methyl; each of R1 and R2 is a PEG group; each of R7, R8, R11, and R12 is H; each of R13 and R14 is sulfo; X is —OH, —NHS, —O-TFP, or —NR-L-maleimide; m is 1; p is 2; and n is 1. In one embodiment, the compound is general formula III, where each of R5 and R6 is methyl; each of R1 and R2 is a PEG group; each of R7, R8, R11, and R12 is H; each of R13 and R14 is sulfo; X is —OH, —NHS, —O-TFP, or —NR-L-maleimide; m is 2; p is 3; and n is 1. In one embodiment, the compound is general formula III, where each of R5 and R6 is methyl; each of R1 and R2 is a PEG group; each of R7, R8, R11, and R12 is H; each of R13 and R14 is sulfo; X is —OH, —NHS, —O-TFP, or —NR-L-maleimide; m is 3; p is 4; and n is 1. In one embodiment, the compound is general formula III, where each of R5 and R6 is methyl; each of R1 and R2 is a PEG group; each of R7, R8, R11, and R12 is H; each of R13 and R14 is sulfo; X is —OH, —NHS, —O-TFP, or —NR-L-maleimide; m is 4; p is 5; and n is 1. In one embodiment, the compound is general formula III, where each of R5 and R6 is methyl; each of R1 and R2 is a PEG group; each of R7, R8, R11, and R12 is H; each of R13 and R14 is sulfo; X is —OH, —NHS, —O-TFP, or —NR-L-maleimide; m is 5; p is 6; and n is 1.

In one embodiment, the compound is general formula III, where each of R5 and R6 is methyl; each of R1 and R2 is a PEG group; each of R7, R8, R11, and R12 is H; each of R13 and R14 is sulfo; X is —OH, —NHS, —O-TFP, or —NR-L-maleimide; m is 0; p is 1; and n is 2. In one embodiment, the compound is general formula III, where each of R5 and R6 is methyl; each of R1 and R2 is a PEG group; each of R7, R8, R11, and R12 is H; each of R13 and R14 is sulfo; X is —OH, —NHS, —O-TFP, or —NR-L-maleimide; m is 1; p is 2; and n is 2. In one embodiment, the compound is general formula III, where each of R5 and R6 is methyl; each of R1 and R2 is a PEG group; each of R7, R8, R11, and R12 is H; each of R13 and R14 is sulfo; X is —OH, —NHS, —O-TFP, or —NR-L-maleimide; m is 2; p is 3; and n is 2. In one embodiment, the compound is general formula III, where each of R5 and R6 is methyl; each of R1 and R2 is a PEG group; each of R7, R8, R11, and R12 is H; each of R13 and R14 is sulfo; X is —OH, —NHS, —O-TFP, or —NR-L-maleimide; m is 3; p is 4; and n is 2. In one embodiment, the compound is general formula III, where each of R5 and R6 is methyl; each of R1 and R2 is a PEG group; each of R7, R8, R11, and R12 is H; each of R13 and R14 is sulfo; X is —OH, —NHS, —O-TFP, or —NR-L-maleimide; m is 4; p is 5; and n is 2. In one embodiment, the compound is general formula III, where each of R5 and R6 is methyl; each of R1 and R2 is a PEG group; each of R7, R8, R11, and R12 is H; each of R13 and R14 is sulfo; X is —OH, —NHS, —O-TFP, or —NR-L-maleimide; m is 5; p is 6; and n is 2.

In one embodiment, the compound is general formula III, where each of R5 and R6 is methyl; each of R1 and R2 is a PEG group; each of R7, R8, R11, and R12 is H; each of R13 and R14 is sulfo; X is —OH, —NHS, —O-TFP, or —NR-L-maleimide; m is 0; p is 1; and n is 3. In one embodiment, the compound is general formula III, where each of R5 and R6 is methyl; each of R1 and R2 is a PEG group; each of R7, R8, R11, and R12 is H; each of R13 and R14 is sulfo; X is —OH, —NHS, —O-TFP, or —NR-L-maleimide; m is 1; p is 2; and n is 3. In one embodiment, the compound is general formula III, where each of R5 and R6 is methyl; each of R1 and R2 is a PEG group; each of R7, R8, R11, and R12 is H; each of R13 and R14 is sulfo; X is —OH, —NHS, —O-TFP, or —NR-L-maleimide; m is 2; p is 3; and n is 3. In one embodiment, the compound is general formula III, where each of R5 and R6 is methyl; each of R1 and R2 is a PEG group; each of R7, R8,

R11, and R12 is H; each of R13 and R14 is sulfo; X is —OH, —NHS, —O-TFP, or —NR-L-maleimide; m is 3; p is 4; and n is 3. In one embodiment, the compound is general formula III, where each of R5 and R6 is methyl; each of R1 and R2 is a PEG group; each of R7, R8, R11, and R12 is H; each of R13 and R14 is sulfo; X is —OH, —NHS, —O-TFP, or —NR-L-maleimide; m is 4; p is 5; and n is 3. In one embodiment, the compound is general formula III, where each of R5 and R6 is methyl; each of R1 and R2 is a PEG group; each of R7, R8, R11, and R12 is H; each of R13 and R14 is sulfo; X is —OH, —NHS, —O-TFP, or —NR-L-maleimide; m is 5; p is 6; and n is 3.

In one embodiment, the compound is general formula III, where each of R5 and R6 is methyl; each of R1 and R2 is a PEG group; each of R7 and R8 is sulfo; each of R11 and R12 is a sulfonamide group —SO_2NH—P where P is a PEG group; each of R13 and R14 is H; X is —OH, —NHS, —O-TFP, or —NR-L-maleimide; m is 0; p is 1; and n is 1. In one embodiment, the compound is general formula III, where each of R5 and R6 is methyl; each of R1 and R2 is a PEG group; each of R7 and R8 is sulfo; each of R11 and R12 is a sulfonamide group —SO_2NH—P where P is a PEG group; each of R13 and R14 is H; X is —OH, —NHS, —O-TFP, or —NR-L-maleimide; m is 1; p is 2; and n is 1. In one embodiment, the compound is general formula III, where each of R5 and R6 is methyl; each of R1 and R2 is a PEG group; each of R7 and R8 is sulfo; each of R11 and R12 is a sulfonamide group —SO_2NH—P where P is a PEG group; each of R13 and R14 is H; X is —OH, —NHS, —O-TFP, or —NR-L-maleimide; m is 2; p is 3; and n is 1. In one embodiment, the compound is general formula III, where each of R5 and R6 is methyl; each of R1 and R2 is a PEG group; each of R7 and R8 is sulfo; each of R11 and R12 is a sulfonamide group —SO_2NH—P where P is a PEG group; each of R13 and R14 is H; X is —OH, —NHS, —O-TFP, or —NR-L-maleimide; m is 3; p is 4; and n is 1. In one embodiment, the compound is general formula III, where each of R5 and R6 is methyl; each of R1 and R2 is a PEG group; each of R7 and R8 is sulfo; each of R11 and R12 is a sulfonamide group —SO_2NH—P where P is a PEG group; each of R13 and R14 is H; X is —OH, —NHS, —O-TFP, or —NR-L-maleimide; m is 4; p is 5; and n is 1. In one embodiment, the compound is general formula III, where each of R5 and R6 is methyl; each of R1 and R2 is a PEG group; each of R7 and R8 is sulfo; each of R11 and R12 is a sulfonamide group —SO_2NH—P where P is a PEG group; each of R13 and R14 is H; X is —OH, —NHS, —O-TFP, or —NR-L-maleimide; m is 5; p is 6; and n is 1.

In one embodiment, the compound is general formula III, where each of R5 and R6 is methyl; each of R1 and R2 is a PEG group; each of R7 and R8 is sulfo; each of R11 and R12 is a sulfonamide group —SO_2NH—P where P is a PEG group; each of R13 and R14 is H; X is —OH, —NHS, —O-TFP, or —NR-L-maleimide; m is 0; p is 1; and n is 2. In one embodiment, the compound is general formula III, where each of R5 and R6 is methyl; each of R1 and R2 is a PEG group; each of R7 and R8 is sulfo; each of R11 and R12 is a sulfonamide group —SO_2NH—P where P is a PEG group; each of R13 and R14 is H; X is —OH, —NHS, —O-TFP, or —NR-L-maleimide; m is 1; p is 2; and n is 2. In one embodiment, the compound is general formula III, where each of R5 and R6 is methyl; each of R1 and R2 is a PEG group; each of R7 and R8 is sulfo; each of R11 and R12 is a sulfonamide group —SO_2NH—P where P is a PEG group; each of R13 and R14 is H; X is —OH, —NHS, —O-TFP, or —NR-L-maleimide; m is 2; p is 3; and n is 2. In one embodiment, the compound is general formula III, where each of R5 and R6 is methyl; each of R1 and R2 is a PEG group; each of R7 and R8 is sulfo; each of R11 and R12 is a sulfonamide group —SO_2NH—P where P is a PEG group; each of R13 and R14 is H; X is —OH, —NHS, —O-TFP, or —NR-L-maleimide; m is 3; p is 4; and n is 2. In one embodiment, the compound is general formula III, where each of R5 and R6 is methyl; each of R1 and R2 is a PEG group; each of R7 and R8 is sulfo; each of R11 and R12 is a sulfonamide group —SO_2NH—P where P is a PEG group; each of R13 and R14 is H; X is —OH, —NHS, —O-TFP, or —NR-L-maleimide; m is 4; p is 5; and n is 2. In one embodiment, the compound is general formula III, where each of R5 and R6 is methyl; each of R1 and R2 is a PEG group; each of R7 and R8 is sulfo; each of R11 and R12 is a sulfonamide group —SO_2NH—P where P is a PEG group; each of R13 and R14 is H; X is —OH, —NHS, —O-TFP, or —NR-L-maleimide; m is 5; p is 6; and n is 2.

In one embodiment, the compound is general formula III, where each of R5 and R6 is methyl; each of R1 and R2 is a PEG group; each of R7 and R8 is sulfo; each of R11 and R12 is a sulfonamide group —SO_2NH—P where P is a PEG group; each of R13 and R14 is H; X is —OH, —NHS, —O-TFP, or —NR-L-maleimide; m is 0; p is 1; and n is 3. In one embodiment, the compound is general formula III, where each of R5 and R6 is methyl; each of R1 and R2 is a PEG group; each of R7 and R8 is sulfo; each of R11 and R12 is a sulfonamide group —SO_2NH—P where P is a PEG group; each of R13 and R14 is H; X is —OH, —NHS, —O-TFP, or —NR-L-maleimide; m is 1; p is 2; and n is 3. In one embodiment, the compound is general formula III, where each of R5 and R6 is methyl; each of R1 and R2 is a PEG group; each of R7 and R8 is sulfo; each of R11 and R12 is a sulfonamide group —SO_2NH—P where P is a PEG group; each of R13 and R14 is H; X is —OH, —NHS, —O-TFP, or —NR-L-maleimide; m is 2; p is 3; and n is 3. In one embodiment, the compound is general formula III, where each of R5 and R6 is methyl; each of R1 and R2 is a PEG group; each of R7 and R8 is sulfo; each of R11 and R12 is a sulfonamide group —SO_2NH—P where P is a PEG group; each of R13 and R14 is H; X is —OH, —NHS, —O-TFP, or —NR-L-maleimide; m is 3; p is 4; and n is 3. In one embodiment, the compound is general formula III, where each of R5 and R6 is methyl; each of R1 and R2 is a PEG group; each of R7 and R8 is sulfo; each of R11 and R12 is a sulfonamide group —SO_2NH—P where P is a PEG group; each of R13 and R14 is H; X is —OH, —NHS, —O-TFP, or —NR-L-maleimide; m is 4; p is 5; and n is 3. In one embodiment, the compound is general formula III, where each of R5 and R6 is methyl; each of R1 and R2 is a PEG group; each of R7 and R8 is sulfo; each of R11 and R12 is a sulfonamide group —SO_2NH—P where P is a PEG group; each of R13 and R14 is H; X is —OH, —NHS, —O-TFP, or —NR-L-maleimide; m is 5; p is 6; and n is 3.

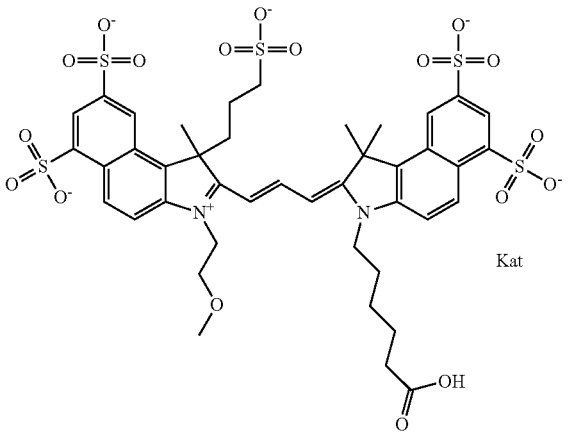
In one embodiment, the compound is general formula III, where each of R5 and R6 is methyl; each of R1 and R2 is a PEG group; each of R7 and R8 is sulfo; each of R11 and R12 is a carboxamide group —CONH—P where P is a PEG group; each of R13 and R14 is H; X is —OH, —NHS, —O-TFP, or —NR-L-maleimide; m is 0; p is 1; and n is 1. In one embodiment, the compound is general formula III, where each of R5 and R6 is methyl; each of R1 and R2 is a PEG group; each of R7 and R8 is sulfo; each of R11 and R12 is a carboxamide group —CONH—P where P is a PEG group; each of R13 and R14 is H; X is —OH, —NHS, —O-TFP, or —NR-L-maleimide; m is 1; p is 2; and n is 1. In one embodiment, the compound is general formula III, where each of R5 and R6 is methyl; each of R1 and R2 is a PEG group; each of R7 and R8 is sulfo; each of R11 and R12 is a carboxamide group —CONH—P where P is a PEG group; each of R13 and R14 is H; X is —OH, —NHS, —O-TFP, or —NR-L-male-

imide; m is 2; p is 3; and n is 1. In one embodiment, the compound is general formula III, where each of R5 and R6 is methyl; each of R1 and R2 is a PEG group; each of R7 and R8 is sulfo; each of R11 and R12 is a carboxamide group —CONH—P where P is a PEG group; each of R13 and R14 is H; X is —OH, —NHS, —O-TFP, or —NR-L-maleimide; m is 3; p is 4; and n is 1. In one embodiment, the compound is general formula III, where each of R5 and R6 is methyl; each of R1 and R2 is a PEG group; each of R7 and R8 is sulfo; each of R11 and R12 is a carboxamide group —CONH—P where P is a PEG group; each of R13 and R14 is H; X is —OH, —NHS, —O-TFP, or —NR-L-maleimide; m is 4; p is 5; and n is 1. In one embodiment, the compound is general formula III, where each of R5 and R6 is methyl; each of R1 and R2 is a PEG group; each of R7 and R8 is sulfo; each of R11 and R12 is a carboxamide group —CONH—P where P is a PEG group; each of R13 and R14 is H; X is —OH, —NHS, —O-TFP, or —NR-L-maleimide; m is 5; p is 6; and n is 1.

In one embodiment, the compound is general formula III, where each of R5 and R6 is methyl; each of R1 and R2 is a PEG group; each of R7 and R8 is sulfo; each of R11 and R12 is a carboxamide group —CONH—P where P is a PEG group; each of R13 and R14 is H; X is —OH, —NHS, —O-TFP, or —NR-L-maleimide; m is 0; p is 1; and n is 2. In one embodiment, the compound is general formula III, where each of R5 and R6 is methyl; each of R1 and R2 is a PEG group; each of R7 and R8 is sulfo; each of R11 and R12 is a carboxamide group —CONH—P where P is a PEG group; each of R13 and R14 is H; X is —OH, —NHS, —O-TFP, or —NR-L-maleimide; m is 1; p is 2; and n is 2. In one embodiment, the compound is general formula III, where each of R5 and R6 is methyl; each of R1 and R2 is a PEG group; each of R7 and R8 is sulfo; each of R11 and R12 is a carboxamide group —CONH—P where P is a PEG group; each of R13 and R14 is H; X is —OH, —NHS, —O-TFP, or —NR-L-maleimide; m is 2; p is 3; and n is 2. In one embodiment, the compound is general formula III, where each of R5 and R6 is methyl; each of R1 and R2 is a PEG group; each of R7 and R8 is sulfo; each of R11 and R12 is a carboxamide group —CONH—P where P is a PEG group; each of R13 and R14 is H; X is —OH, —NHS, —O-TFP, or —NR-L-maleimide; m is 3; p is 4; and n is 2. In one embodiment, the compound is general formula III, where each of R5 and R6 is methyl; each of R1 and R2 is a PEG group; each of R7 and R8 is sulfo; each of R11 and R12 is a carboxamide group —CONH—P where P is a PEG group; each of R13 and R14 is H; X is —OH, —NHS, —O-TFP, or —NR-L-maleimide; m is 4; p is 5; and n is 2. In one embodiment, the compound is general formula III, where each of R5 and R6 is methyl; each of R1 and R2 is a PEG group; each of R7 and R8 is sulfo; each of R11 and R12 is a carboxamide group —CONH—P where P is a PEG group; each of R13 and R14 is H; X is —OH, —NHS, —O-TFP, or —NR-L-maleimide; m is 5; p is 6; and n is 2.

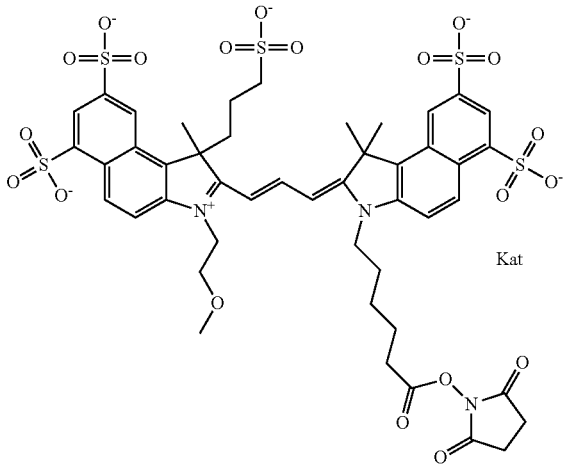
In one embodiment, the compound is general formula III, where each of R5 and R6 is methyl; each of R1 and R2 is a PEG group; each of R7 and R8 is sulfo; each of R11 and R12 is a carboxamide group —CONH—P where P is a PEG group; each of R13 and R14 is H; X is —OH, —NHS, —O-TFP, or —NR-L-maleimide; m is 0; p is 1; and n is 3. In one embodiment, the compound is general formula III, where each of R5 and R6 is methyl; each of R1 and R2 is a PEG group; each of R7 and R8 is sulfo; each of R11 and R12 is a carboxamide group —CONH—P where P is a PEG group; each of R13 and R14 is H; X is —OH, —NHS, —O-TFP, or —NR-L-maleimide; m is 1; p is 2; and n is 3. In one embodiment, the compound is general formula III, where each of R5 and R6 is methyl; each of R1 and R2 is a PEG group; each of R7 and R8 is sulfo; each of R11 and R12 is a carboxamide group —CONH—P where P is a PEG group; each of R13 and R14 is H; X is —OH, —NHS, —O-TFP, or —NR-L-maleimide; m is 2; p is 3; and n is 3. In one embodiment, the compound is general formula III, where each of R5 and R6 is methyl; each of R1 and R2 is a PEG group; each of R7 and R8 is sulfo; each of R11 and R12 is a carboxamide group —CONH—P where P is a PEG group; each of R13 and R14 is H; X is —OH, —NHS, —O-TFP, or —NR-L-maleimide; m is 3; p is 4; and n is 3. In one embodiment, the compound is general formula III, where each of R5 and R6 is methyl; each of R1 and R2 is a PEG group; each of R7 and R8 is sulfo; each of R11 and R12 is a carboxamide group —CONH—P where P is a PEG group; each of R13 and R14 is H; X is —OH, —NHS, —O-TFP, or —NR-L-maleimide; m is 4; p is 5; and n is 3. In one embodiment, the compound is general formula III, where each of R5 and R6 is methyl; each of R1 and R2 is a PEG group; each of R7 and R8 is sulfo; each of R11 and R12 is a carboxamide group —CONH—P where P is a PEG group; each of R13 and R14 is H; X is —OH, —NHS, —O-TFP, or —NR-L-maleimide; m is 5; p is 6; and n is 3.

In one embodiment, the compound is 579 Compound 1

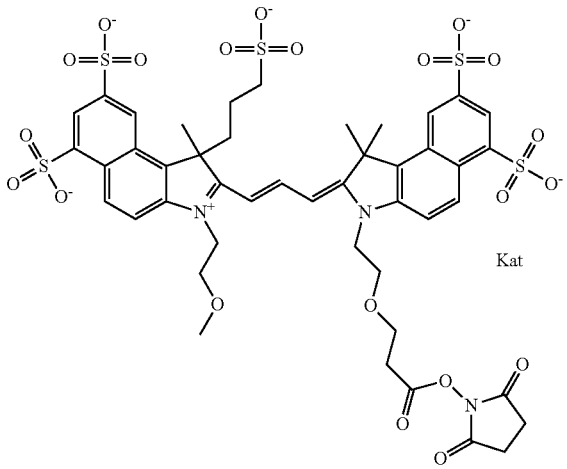


579 Compound 1 (6-((E)-2-((E)-3-(3-(2-methoxyethyl)-1-methyl-6,8-disulfonato-1-(3-sulfonatopropyl)-1H-benzo[e]indol-3-ium-2-yl)allylidene)-1,1-dimethyl-6,8-disulfonato-1H-benzo[e]indol-3(2H)-yl)hexanoate) contains an ethylene glycol on the indole N of the left heterocycle, i.e., a methylated ethylene glycol. The methyl group on the ethylene glycol prevents the terminal —OH from oxidation. Oxidation is known to occur, over time, on an unprotected PEG terminus. Adding a methyl ether provides this protection, and prevents reaction with electrophilic reactive groups.

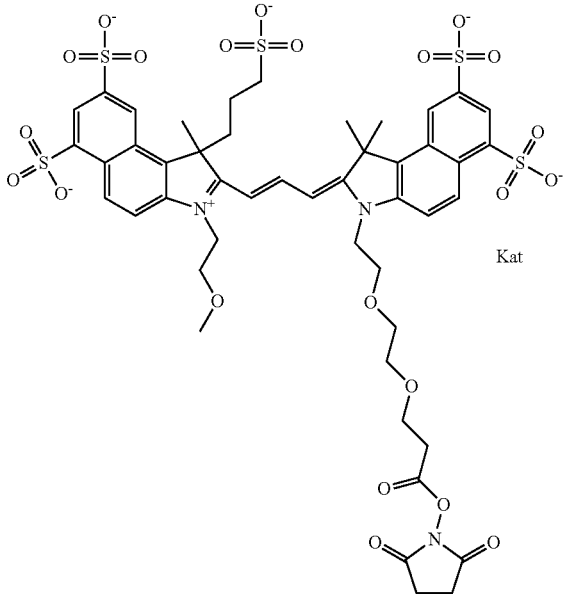
In embodiments, e.g., for functional assays, the inventive compounds are activated. Activation of the compound adds a chemical moiety such that the compound is in a form that can be conjugated to a biological moiety. Examples of chemical moieties for activation are described below with reference to activation of 579 Compound 1, but one skilled in the art appreciates that activation is not limited to these examples. One non-limiting example of an activated compound is the NHS-ester of 579 Compound 1, shown below:



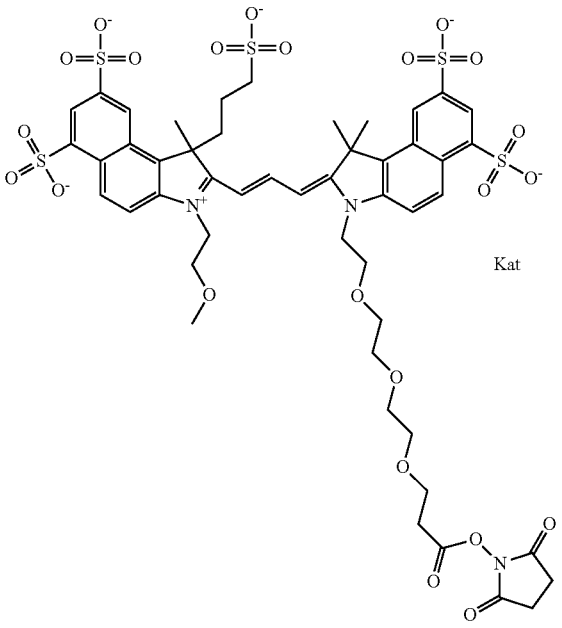
One non-limiting example of a NHS-ester of 579 Compound 1, according to general formula III, where m=1 and p=1, is shown below:



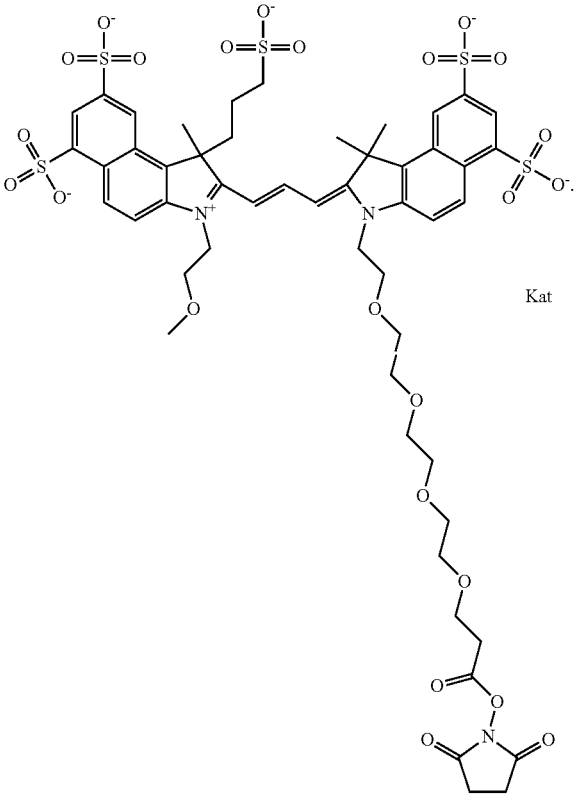
One non-limiting example of a NHS-ester of 579 Compound 1, according to general formula III, where m=1 and p=2, is shown below:



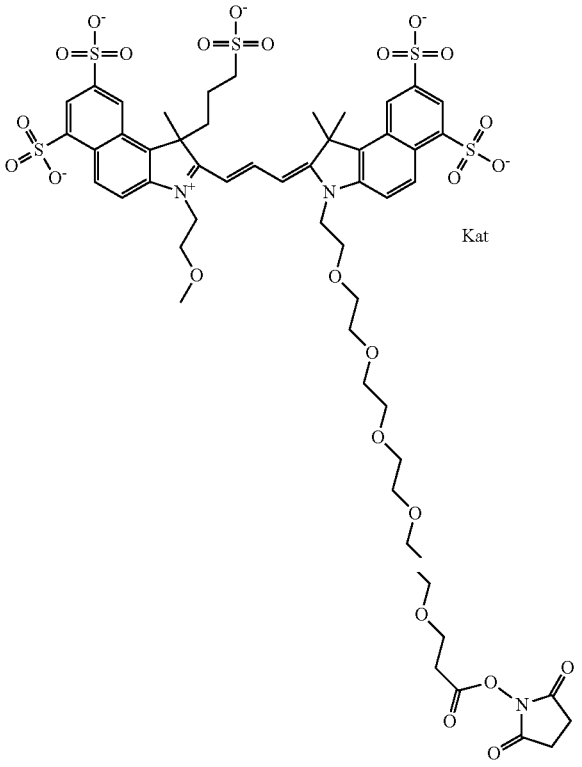
One non-limiting example of a NHS-ester of 579 Compound 1, according to general formula III, where m=1 and p=3, is shown below:



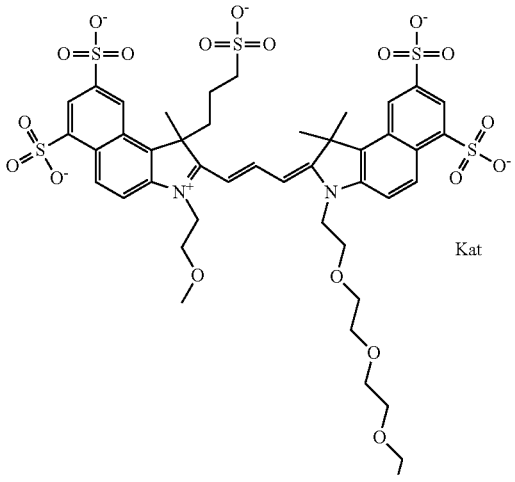
One non-limiting example of a NHS-ester of 579 Compound 1, according to general formula III, where m=1 and p=4, is shown below:



One non-limiting example of a NHS-ester of 579 Compound 1, according to general formula III, where m=1 and p=5, is shown below:



One non-limiting example of a NHS-ester of 579 Compound 1, according to general formula III, where m=1 and p=6, is shown below:



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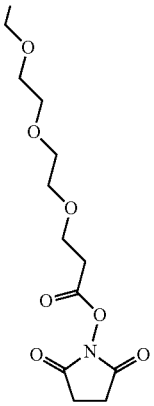
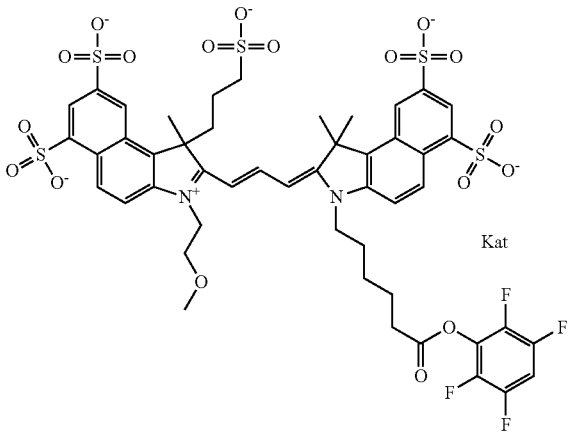
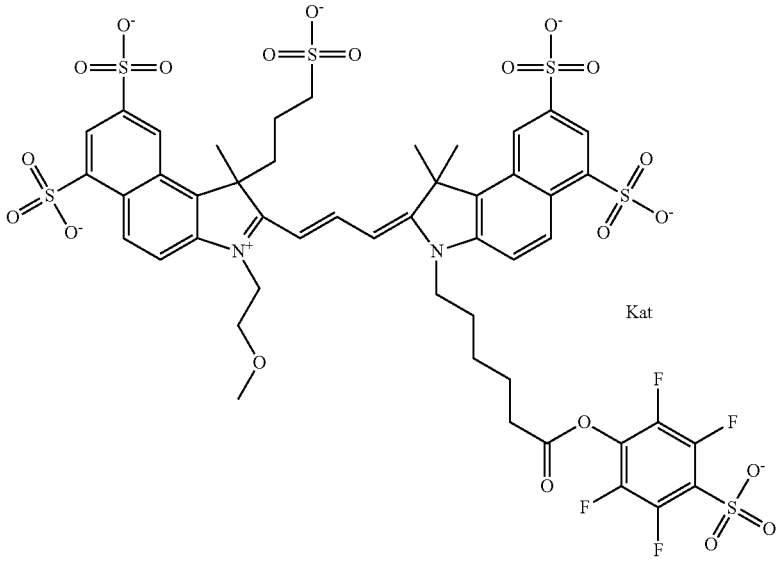


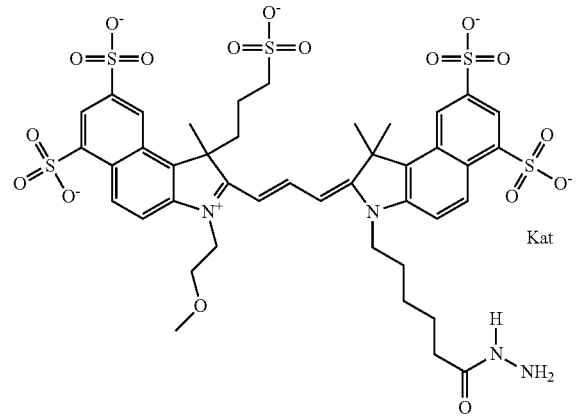
One non-limiting example of an activated 579 Compound 1 is a tetrafluorophenyl (TFP)-ester form of 579 Compound 1, shown below:



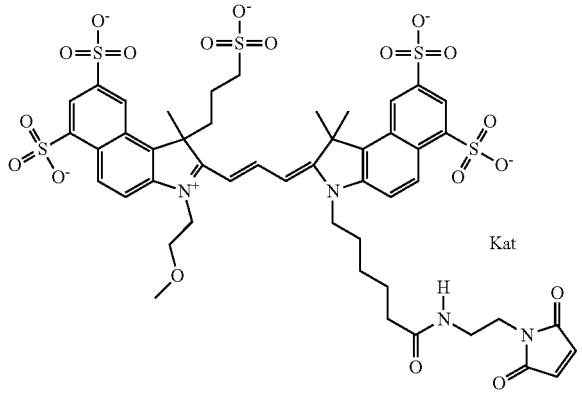
One non-limiting example of an activated 579 Compound 1 is a sulfotetrafluorophenyl (STP)-ester form of 579 Compound 1, shown below:



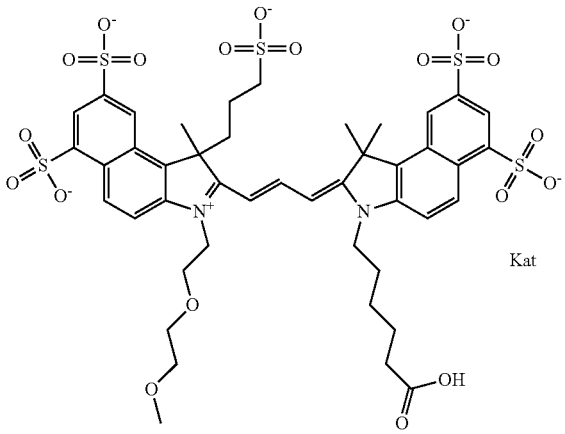
One non-limiting example of an activated 579 Compound 1 is a hydrazide form of 579 Compound 1, shown below:



One non-limiting example of an activated 579 Compound 1 is a maleimide form of 579 Compound 1, shown below:

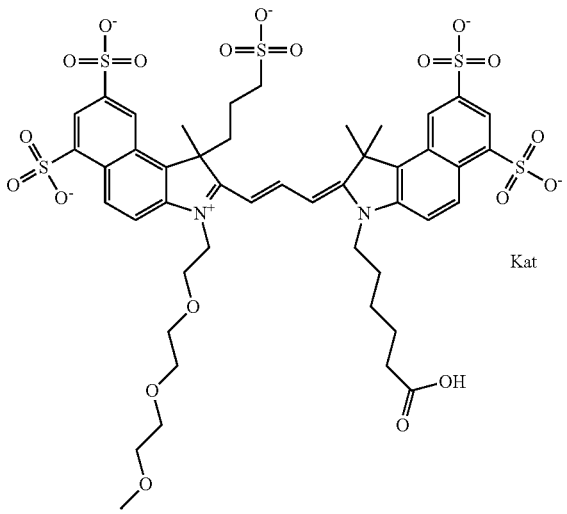


In one embodiment, the compound is 579 Compound 2



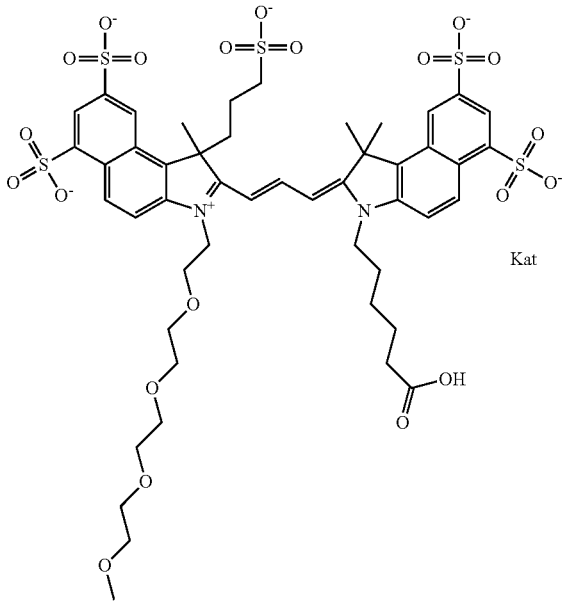
579 Compound 2 (6-((E)-2-(E)-3-(3-(2-(2-methoxyethoxy)ethyl)-1-methyl-6,8-disulfonato-1-(3-sulfonatopropyl)-1H-benzo[e]indol-3-ium-2-yl)allylidene)-1,1-dimethyl-6,8-disulfonato-1H-benzo[e]indol-3(2H)-yl) hexanoate) contains a (poly)ethylene glycol on the indole N of the left heterocycle. The methyl group on the ethylene glycol prevents the terminal —OH from oxidation. Oxidation is known to occur, over time, on an unprotected PEG terminus. Adding a methyl ether provides this protection, and prevents reaction with electrophilic reactive groups. For functional assays, 579 Compound 2 is activated as described above.

In one embodiment, the compound is 579 Compound 3



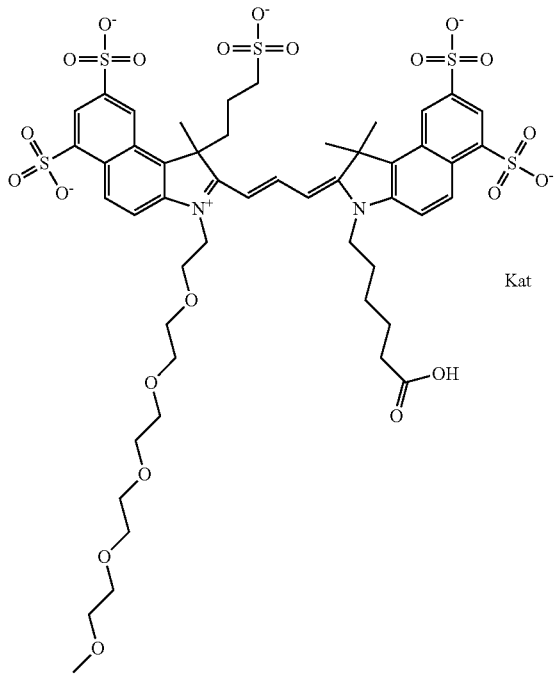
579 Compound 3 (6-((E)-2-((E)-3-(3-(2-(2-(2-methoxyethoxy)ethoxy)ethyl)-1-methyl-6,8-disulfonato-1-(3-sulfonatopropyl)-1H-benzo[e]indol-3-ium-2-yl)allylidene)-1,1-dimethyl-6,8-disulfonato-1H-benzo[e]indol-3(2H)-yl) hexanoate) contains a (poly)ethylene glycol on the indole N of the left heterocycle. The methyl group on the ethylene glycol prevents the terminal —OH from oxidation. Oxidation is known to occur, over time, on an unprotected PEG terminus. Adding a methyl ether provides this protection, and prevents reaction with electrophilic reactive groups. For functional assays, 579 Compound 3 is activated as described above.

In one embodiment, the compound is 579 Compound 4



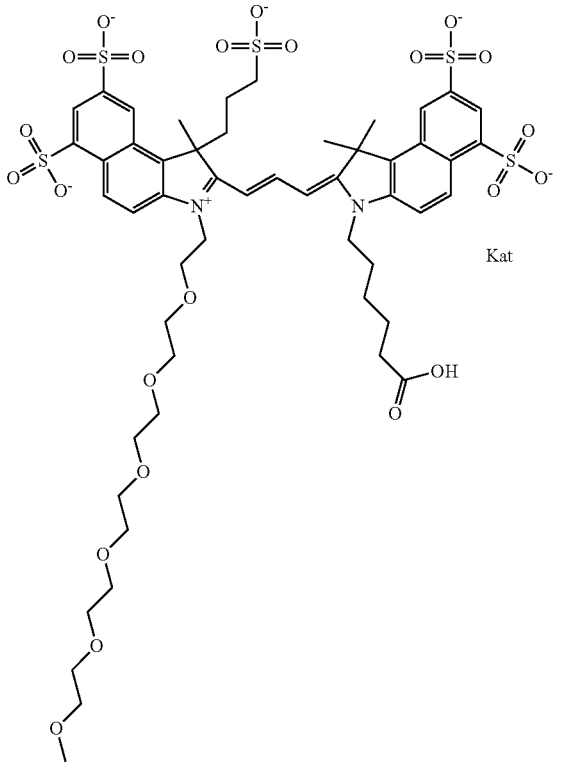
579 Compound 4 (6-((E)-1,1-dimethyl-2-((E)-3-(1-methyl-6,8-disulfonato-1-(3-sulfonatopropyl)-3-(2,5,8,11-tetraoxatridecan-13-yl)-1H-benzo[e]indol-3-ium-2-yl)allylidene)-6,8-disulfonato-1H-benzo[e]indol-3(2H)-yl) hexanoate) contains a (poly)ethylene glycol on the indole N of the left heterocycle. The methyl group on the ethylene glycol prevents the terminal —OH from oxidation. Oxidation is known to occur, over time, on an unprotected PEG terminus. Adding a methyl ether provides this protection, and prevents reaction with electrophilic reactive groups. For functional assays, 579 Compound 4 is activated as described above.

In one embodiment, the compound is 579 Compound 5



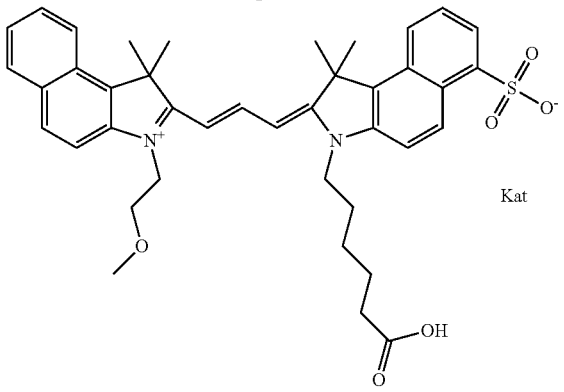
579 Compound 5 (6-((E)-2-((E)-3-(3-(2,5,8,11,14-pentaoxahexadecan-16-yl)-1-methyl-6,8-disulfonato-1-(3-sulfonatopropyl)-1H-benzo[e]indol-3-ium-2-yl)allylidene)-1,1-dimethyl-6,8-disulfonato-1H-benzo[e]indol-3(2H)-yl) hexanoate) contains a (poly)ethylene glycol on the indole N of the left heterocycle. The methyl group on the ethylene glycol prevents the terminal —OH from oxidation. Oxidation is known to occur, over time, on an unprotected PEG terminus. Adding a methyl ether provides this protection, and prevents reaction with electrophilic reactive groups. For functional assays, 579 Compound 5 is activated as described above.

In one embodiment, the compound is 579 Compound 6

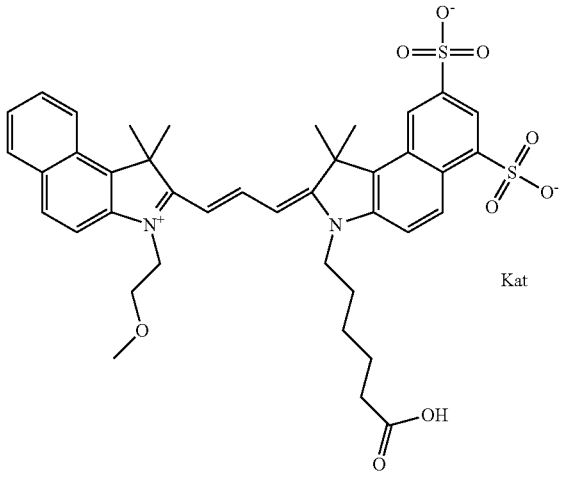


579 Compound 6 (6-((E)-1,1-dimethyl-2-((E)-3-(1-methyl-3-(2,5,8,11,14,17-hexaoxanonadecan-19-yl)-6,8-disulfonato-1-(3-sulfonatopropyl)-1H-benzo[e]indol-3-ium-2-yl) allylidene)-6,8-disulfonato-1H-benzo[e]indol-3(2H)-yl) hexanoate) contains a (poly)ethylene glycol on the indole N of the left heterocycle. The methyl group on the ethylene glycol prevents the terminal —OH from oxidation. Oxidation is known to occur, over time, on an unprotected PEG terminus. Adding a methyl ether provides this protection, and prevents reaction with electrophilic reactive groups. For functional assays, 579 Compound 6 is activated as described above.

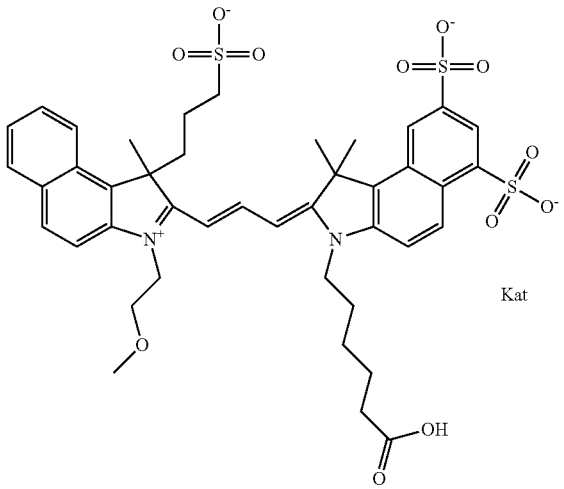
In embodiments, the degree and/or location of sulfonation is varied to, e.g., vary the compound's degree of hydrophilicity or hydrophobicity. One non-limiting example is a monosulfonate form of 579 Compound 1, shown below:



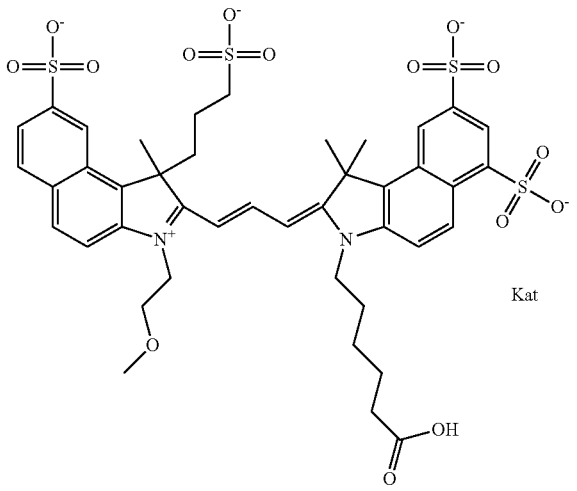
One non-limiting example is a disulfonate form of 579 Compound 1, shown below:



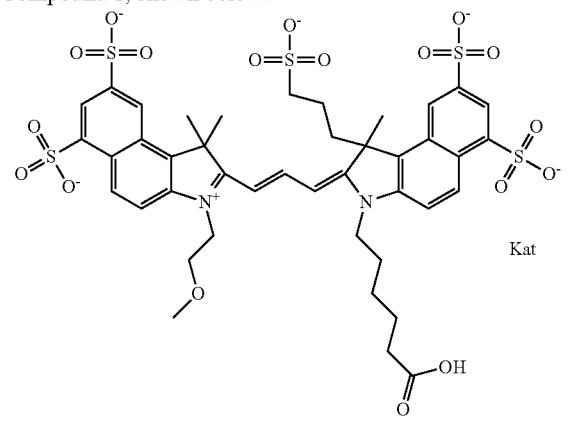
One non-limiting example is a trisulfonate form of 579 Compound 1, shown below:



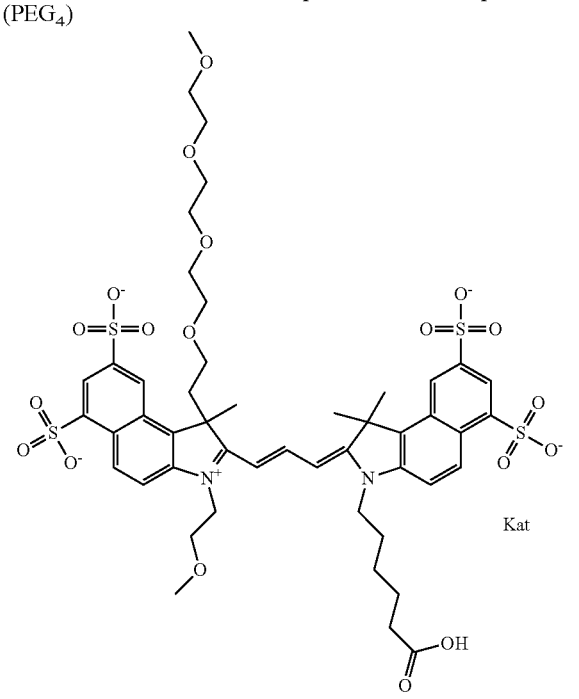
One non-limiting example is a tetrasulfonate form of 579 Compound 1, shown below:



One non-limiting example is a pentasulfonate form of 579 Compound 1, shown below:

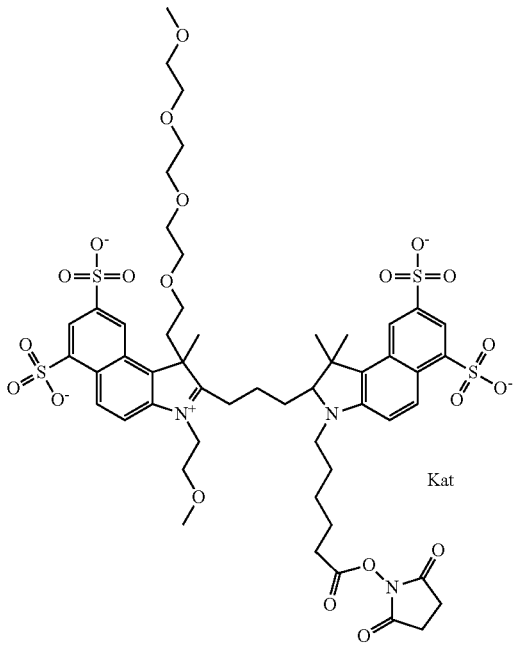


In one embodiment, the compound is 579 Compound 1/2 (PEG_4)

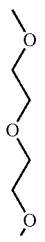


One non-limiting example of 579 Compound 1/2 (PEG_4) (2-((1E,3E)-3-(3-(5-carboxypentyl)-1,1-dimethyl-6,8-disulfonato-1H-benzo[e]indol-2(3H)-ylidene)prop-1-enyl)-3-(2-methoxyethyl)-1-methyl-1-(2,5,8,11-tetraoxatridecan-13-yl)-1H-benzo[e]indolium-6,8-disulfonate) contains an ethylene glycol on the indole N of the left heterocycle, i.e., a methylated ethylene glycol, and a methylated PEG_4 group. The methyl group on the ethylene glycol/PEG prevents the terminal —OH from oxidation. Oxidation is known to occur, over time, on an unprotected PEG terminus. Adding a methyl ether provides this protection, and prevents reaction with electrophilic reactive groups.

In embodiments, e.g., for functional assays, the inventive compounds are activated. Activation of the compound adds a chemical moiety such that the compound is in a form that can be conjugated to a biological moiety. Examples of chemical moieties for activation are described below with reference to activation of 579 Compound 1/2 (PEG_4), but one skilled in the art appreciates that activation is not limited to these examples. One non-limiting example of an activated compound is the NHS-ester of 579 Compound 1/2 (PEG_4), shown below:



One non-limiting example of a NHS-ester of 579 Compound 1/3 (PEG_4), according to general formula III, where m=1 and p=1, is shown below:



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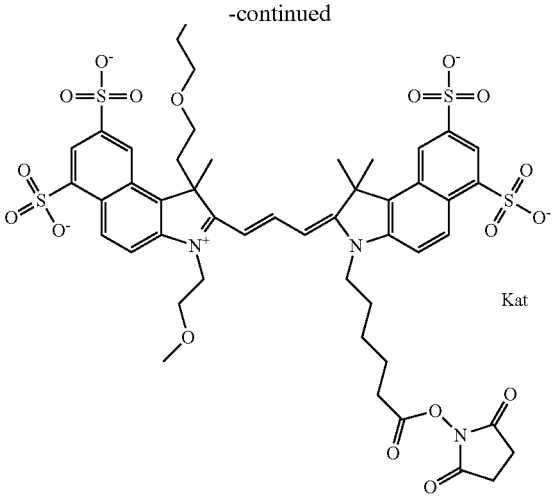
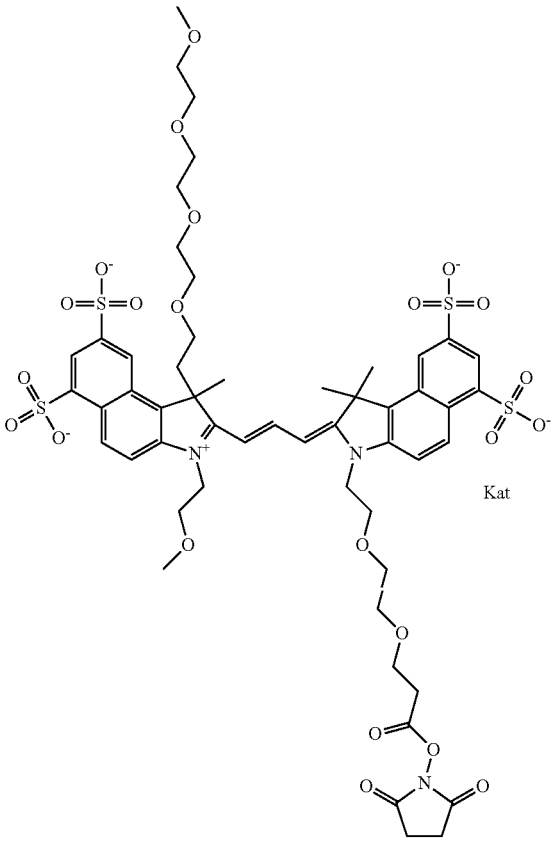
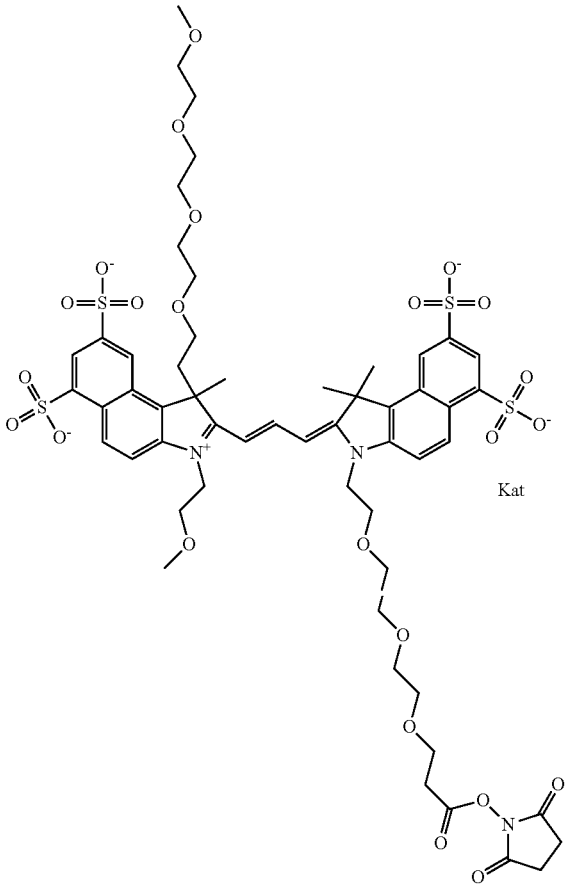


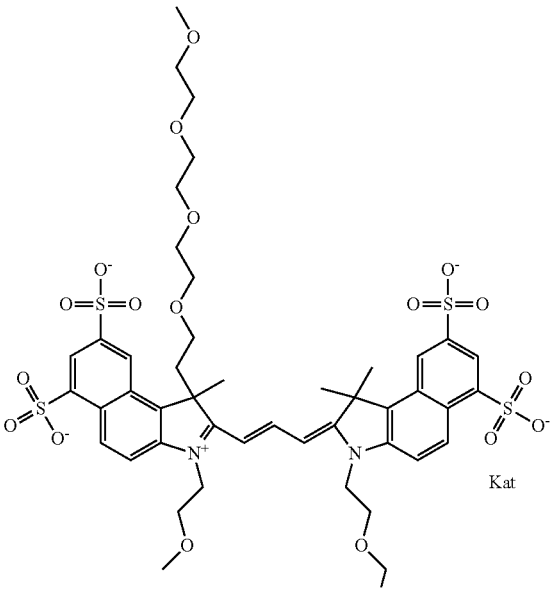
One non-limiting example of a NHS-ester of 579 Compound 1/3 (PEG_4), according to general formula III, where m=1 and p=2, is shown below:



One non-limiting example of a NHS-ester of 579 Compound 1/3 (PEG_4), according to general formula III, where m=1 and p=3, is shown below:



One non-limiting example of a NHS-ester of 579 Compound 1/3 (PEG_4), according to general formula III, where m=1 and p=4, is shown below:



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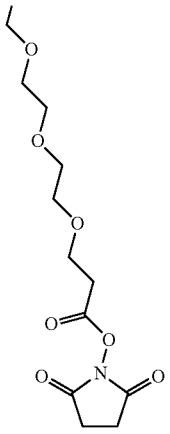
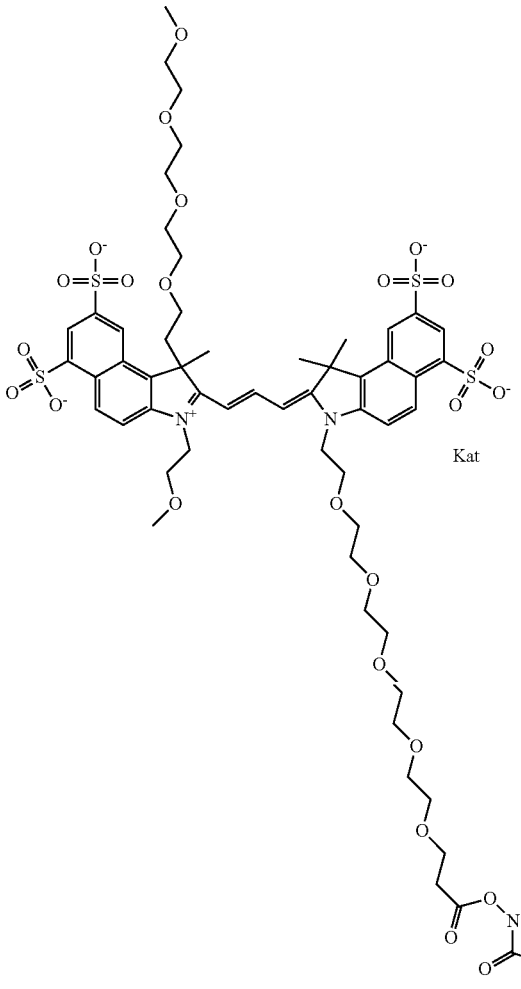
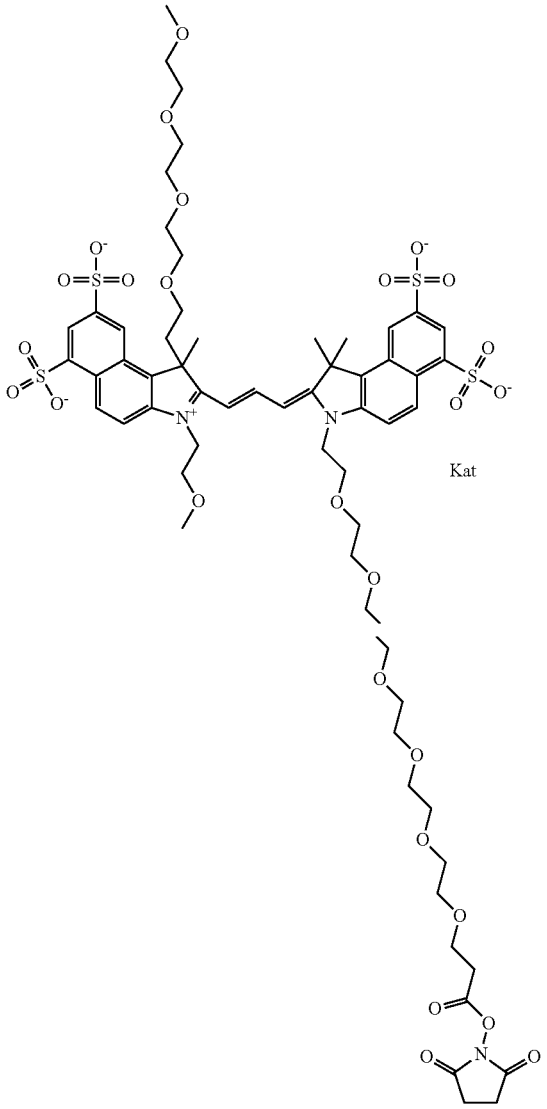


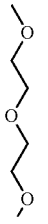
One non-limiting example of a NHS-ester of 579 Compound 1/3 (PEG_4), according to general formula III, where m=1 and p=5, is shown below:



One non-limiting example of a NHS-ester of 579 Compound 1/3 (PEG_4), according to general formula III, where m=1 and p=6, is shown below:



One non-limiting example of an activated 579 Compound 1/2 (PEG_4) is a tetrafluorophenyl (TFP)-ester form of 579 Compound 1, shown below:



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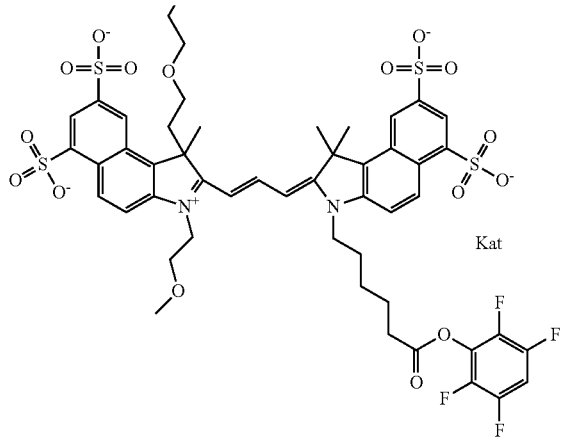
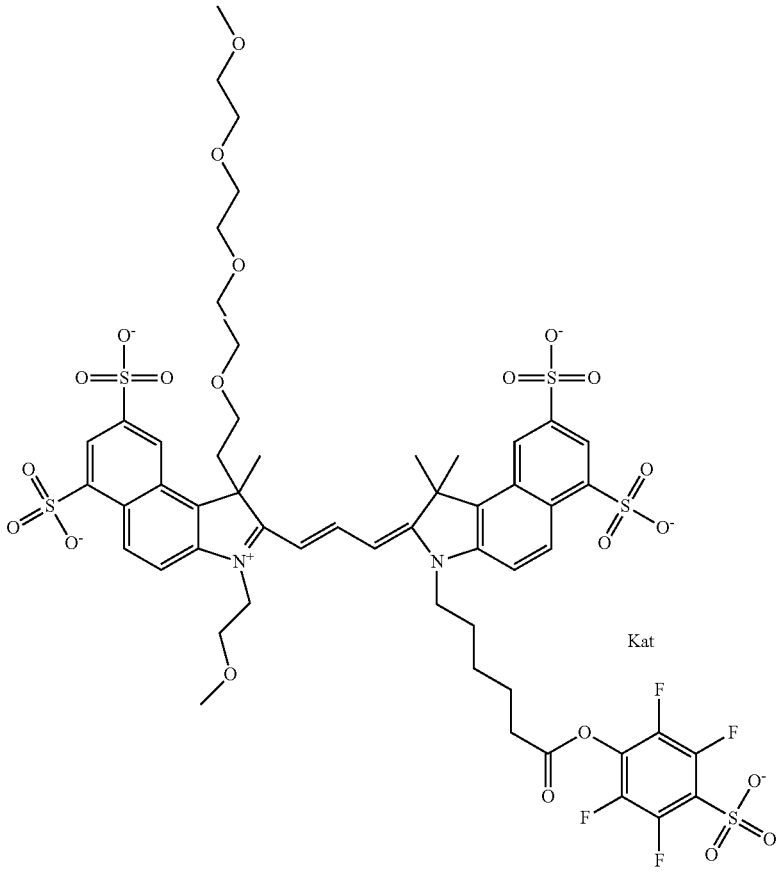
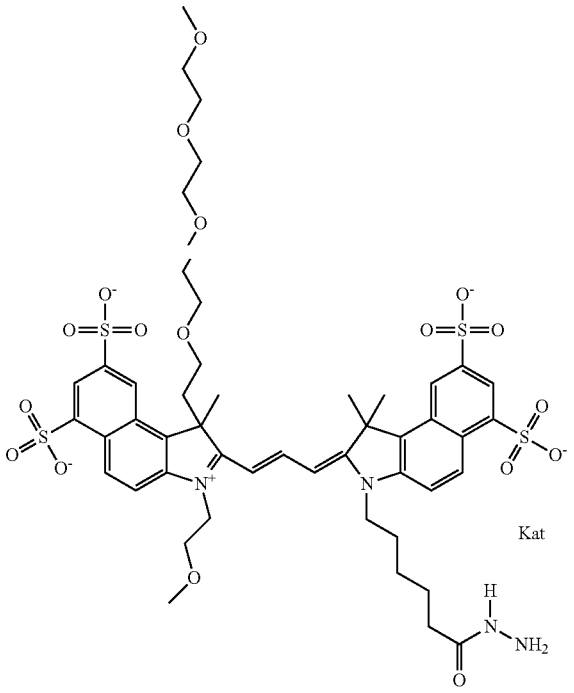


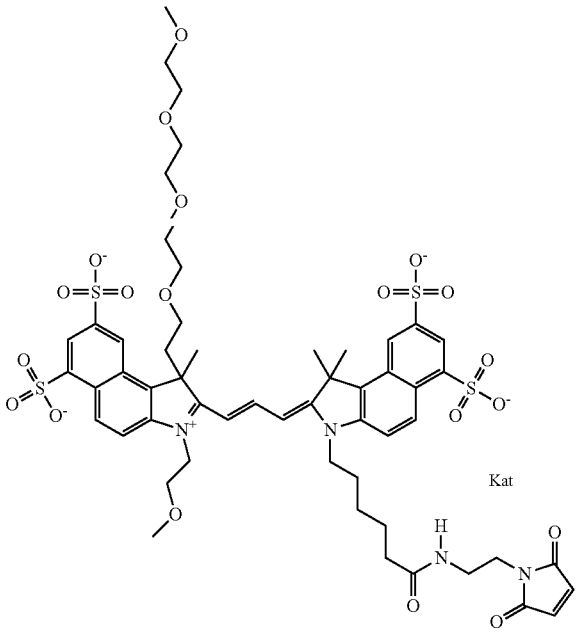
One non-limiting example of an activated 579 Compound 1/2 (PEG_4) is a sulfotetrafluorophenyl (STP)-ester form of 579 Compound 1, shown below:



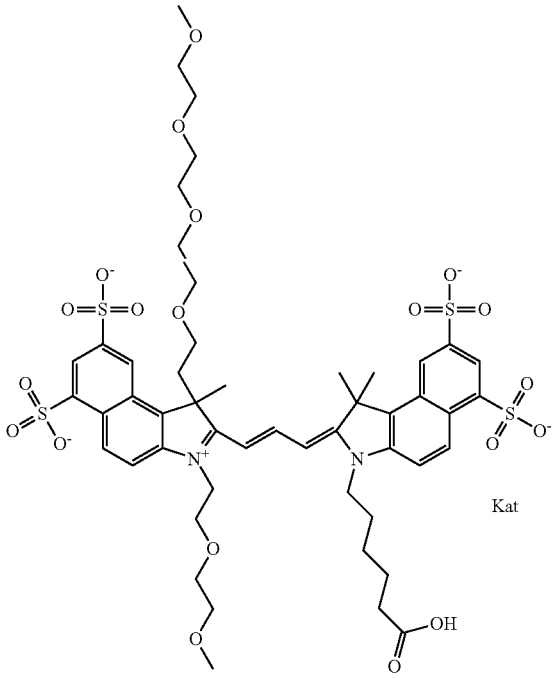
One non-limiting example of an activated 579 Compound 1/2 is a hydrazide form of 579 Compound 1 (PEG_4), shown below:



One non-limiting example of an activated 579 Compound 1/2 (PEG_4) is a maleimide form of 579 Compound 1, shown below:

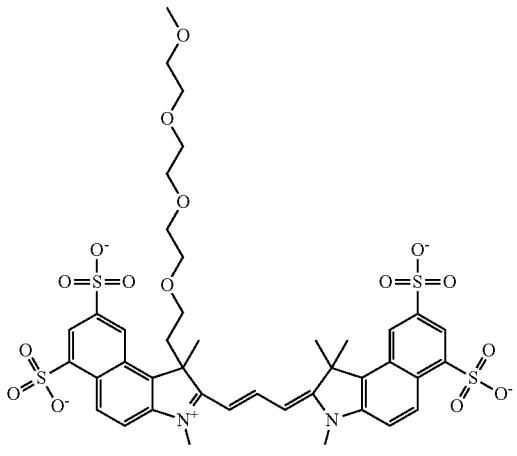


In one embodiment, the compound is 579 Compound 2/2 (PEG_4)



One non-limiting example of 579 Compound 2/2 (PEG_4) (2-((1E,3E)-3-(3-(5-carboxypentyl)-1,1-dimethyl-6,8-disulfonato-1H-benzo[e]indol-2(3H)-ylidene)prop-1-enyl)-3-(2-(2-methoxyethoxy)ethyl)-1-methyl-1-(2,5,8,11-tetraoxatridecan-13-yl)-1H-benzo[e]indolium-6,8-disulfonate) contains a (poly)ethylene glycol on the indole N of the left heterocycle and a PEG_4 group on the indole C. The methyl group on the (poly)ethylene glycol prevents the terminal —OH from oxidation. Oxidation is known to occur, over time, on an unprotected PEG terminus. Adding a methyl ether provides this protection, and prevents reaction with electrophilic reactive groups. For functional assays, 579 Compound 2/2 (PEG_4) is activated as described above.

In one embodiment, the compound is 579 Compound 3/2 (PEG_4)



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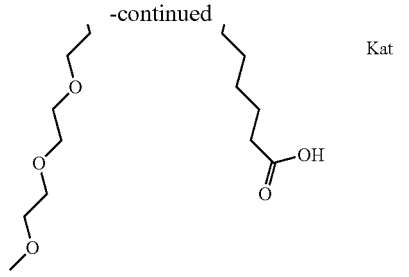
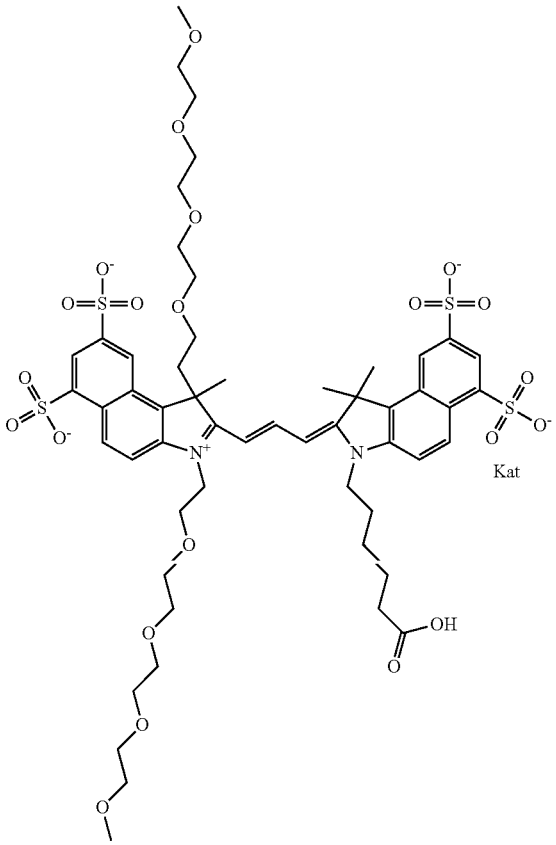


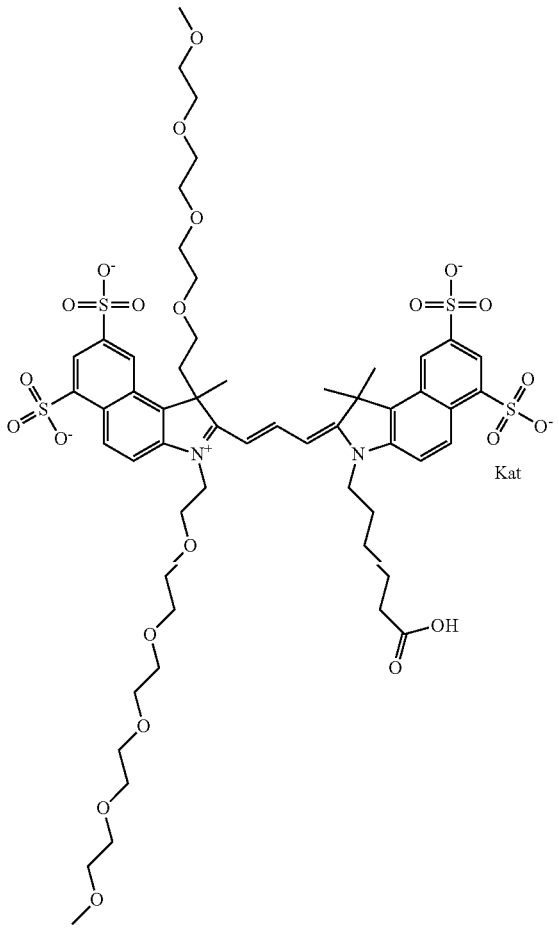
One non-limiting example of 579 Compound 3/2 (PEG_4) (2-((1E,3E)-3-(3-(5-carboxypentyl)-1,1-dimethyl-6,8-disulfonato-1H-benzo[e]indol-2(3H)-ylidene)prop-1-enyl)-3-(2-(2-(2-methoxyethoxy)ethoxy)ethyl)-1-methyl-1-(2,5,8,11-tetraoxatridecan-13-yl)-1H-benzo[e]indolium-6,8-disulfonate) contains a (poly)ethylene glycol on the indole N of the left heterocycle and a PEG_4 group on the indole C. The methyl group on the ethylene glycol prevents the terminal —OH from oxidation. Oxidation is known to occur, over time, on an unprotected PEG terminus. Adding a methyl ether provides this protection, and prevents reaction with electrophilic reactive groups. For functional assays, 579 Compound 3/2 (PEG_4) is activated as described above.

In one embodiment, the compound is 579 Compound 4/2 (PEG_4)



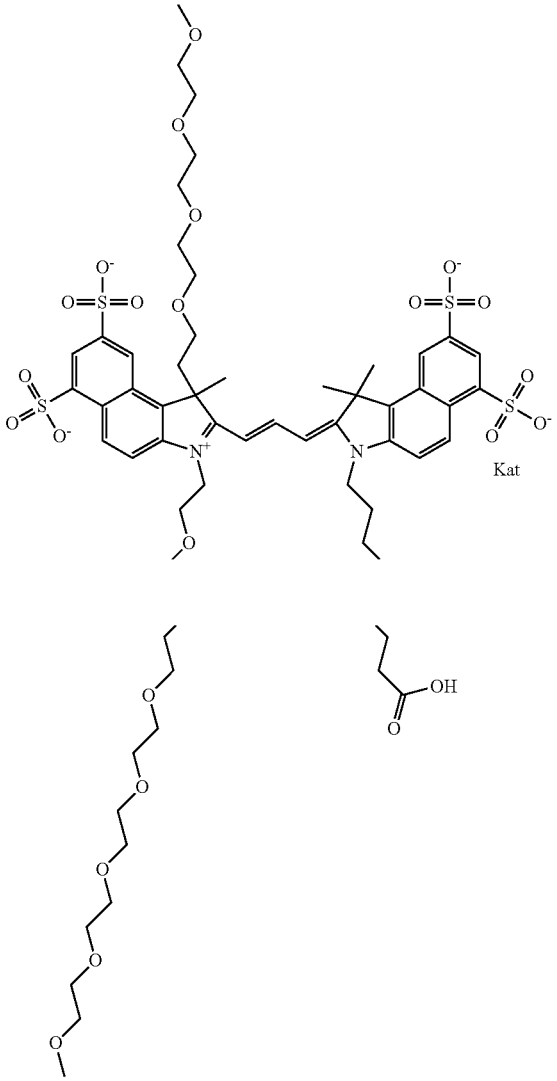
One non-limiting example of 579 Compound 4/2 (PEG_4) (2-((1E,3E)-3-(3-(5-carboxypentyl)-1,1-dimethyl-6,8-disulfonato-1H-benzo[e]indol-2(3H)-ylidene)prop-1-enyl)-1-methyl-1,3-di(2,5,8,11-tetraoxatridecan-13-yl)-1H-benzo[e]indolium-6,8-disulfonate) contains a (poly)ethylene glycol on the indole N of the left heterocycle and a PEG_4 group on the indole C. The methyl group on the ethylene glycol prevents the terminal —OH from oxidation. Oxidation is known to occur, over time, on an unprotected PEG terminus. Adding a methyl ether provides this protection, and prevents reaction with electrophilic reactive groups. For functional assays, 579 Compound 4/2 (PEG_4) is activated as described above.

In one embodiment, the compound is 579 Compound 5/2 (PEG_4)



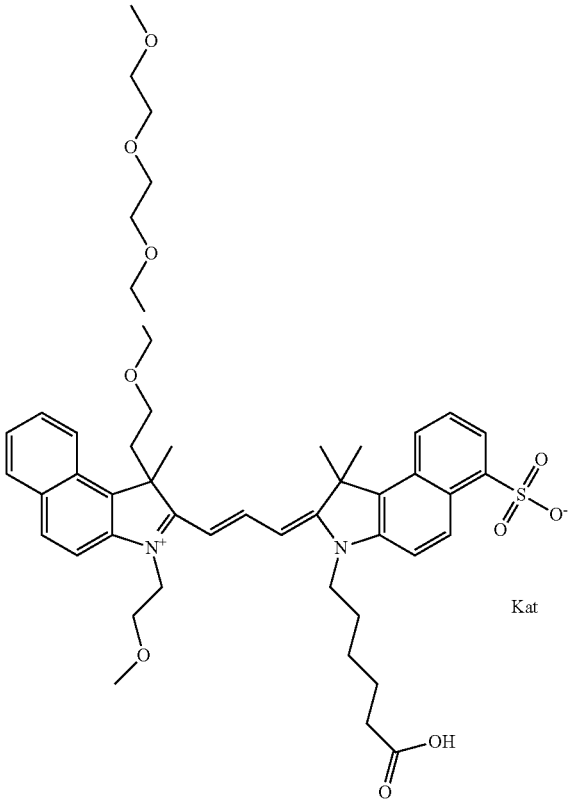
One non-limiting example of 579 Compound 5/2 (PEG_4) (2-((1E,3E)-3-(3-(5-carboxypentyl)-1,1-dimethyl-6,8-disulfonato-1H-benzo[e]indol-2(3H)-ylidene)prop-1-enyl)-3-(2,5,8,11,14-pentaoxahexadecan-16-yl)-1-methyl-1-(2,5,8,11-tetraoxatridecan-13-yl)-1H-benzo[e]indolium-6,8-disulfonate) contains a (poly)ethylene glycol on the indole N of the left heterocycle and a PEG_4 group on the indole C. The methyl group on the ethylene glycol prevents the terminal —OH from oxidation. Oxidation is known to occur, over time, on an unprotected PEG terminus. Adding a methyl ether provides this protection, and prevents reaction with electrophilic reactive groups. For functional assays, 579 Compound 5/2 (PEG_4) is activated as described above.

In one embodiment, the compound is 579 Compound 6/2 (PEG_4)

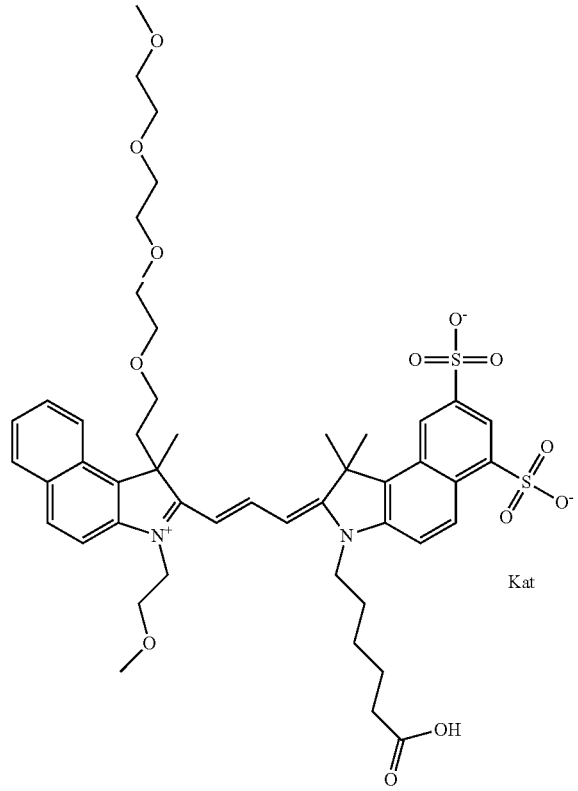


One non-limiting example of 579 Compound 6/2 (PEG_4) (2-((1E,3E)-3-(3-(5-carboxypentyl)-1,1-dimethyl-6,8-disulfonato-1H-benzo[e]indol-2(3H)-ylidene)prop-1-enyl)-1-methyl-3-(2,5,8,11,14,17-hexaoxanonadecan-19-yl)-1-(2,5,8,11-tetraoxatridecan-13-yl)-1H-benzo[e]indolium-6,8-disulfonate) contains a (poly)ethylene glycol on the indole N of the left heterocycle and a PEG_4 group on the indole C. The methyl group on the ethylene glycol prevents the terminal —OH from oxidation. Oxidation is known to occur, over time, on an unprotected PEG terminus. Adding a methyl ether provides this protection, and prevents reaction with electrophilic reactive groups. For functional assays, 579 Compound 6/2 (PEG_4) is activated as described above.

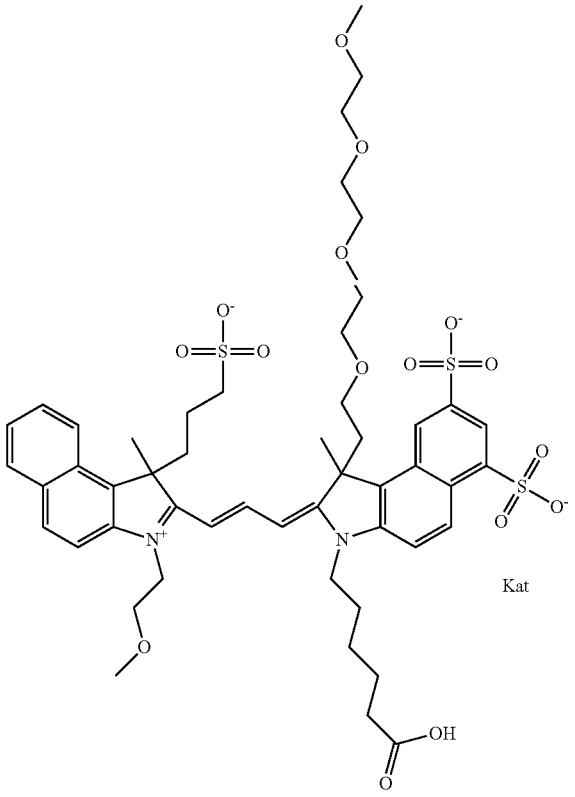
In embodiments, the degree and/or location of sulfonation is varied to, e.g., vary the compound's degree of hydrophilicity or hydrophobicity. One non-limiting example is a monosulfonate form of 579 Compound 1/2 (PEG_4), shown below:



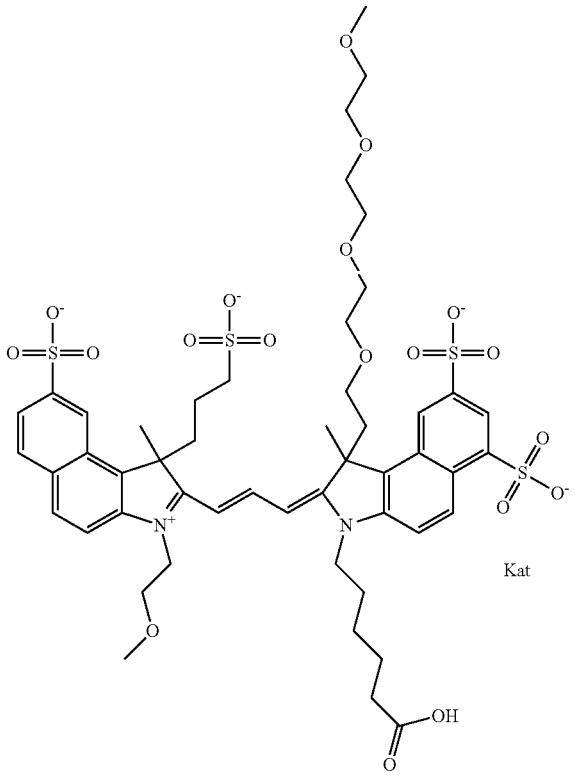
One non-limiting example is a disulfonate form of 579 Compound 1/2 (PEG_4), shown below:



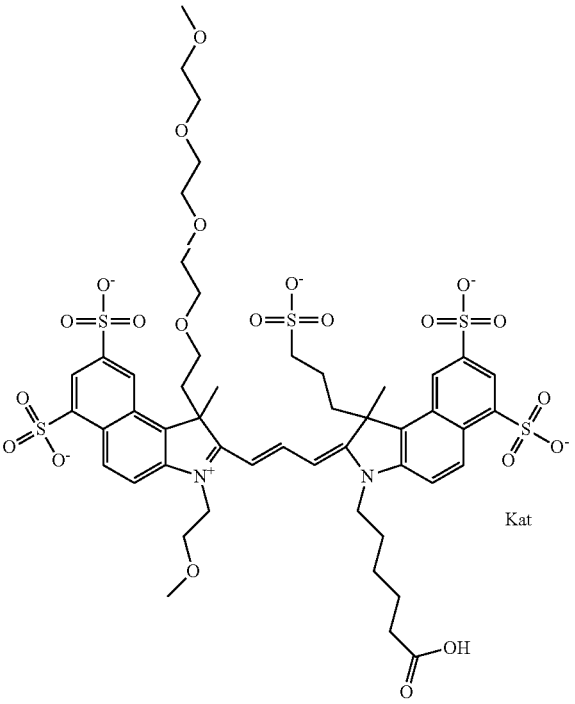
One non-limiting example is a trisulfonate form of 579 Compound 1/2 (PEG_4), shown below:



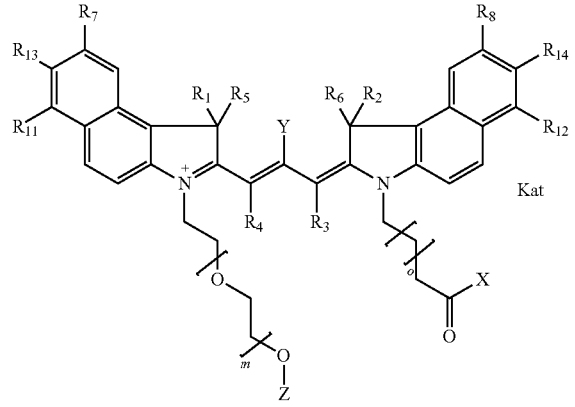
One non-limiting example is a tetrasulfonate form of 579 Compound 1/2 (PEG_4), shown below:



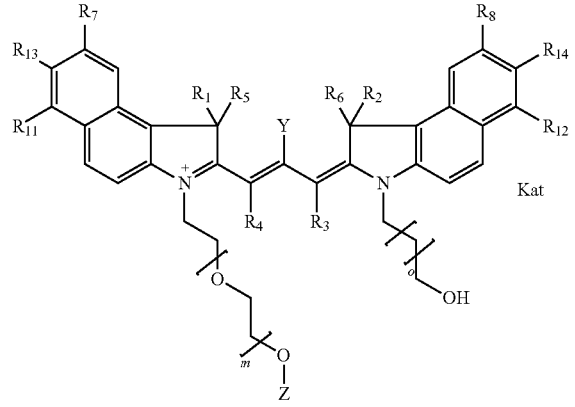
One non-limiting example is a pentasulfonate form of 579 Compound 1/2 (PEG_4), shown below:



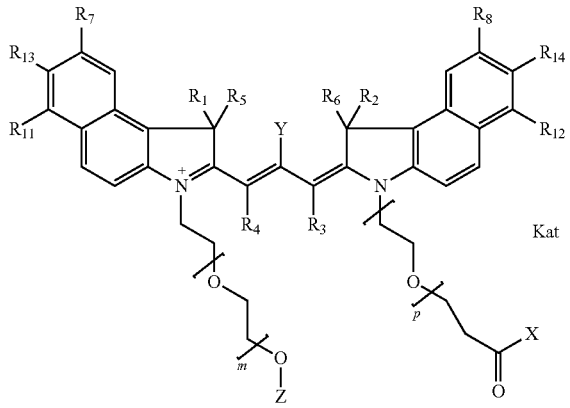
In embodiments, the compound contains one or more substitutions of the polymethine linker. In one embodiment, the compound has general formula IVa



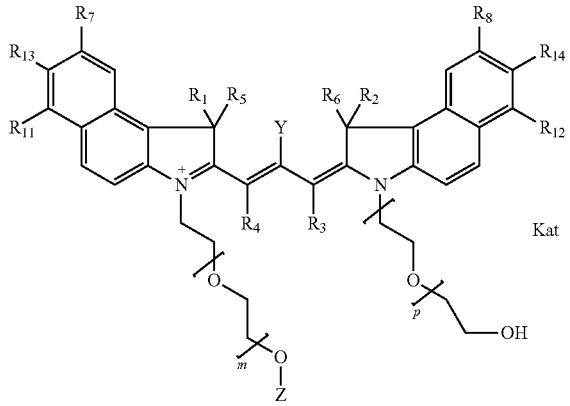
general formula IVb



general formula IVc



or general formula IVd

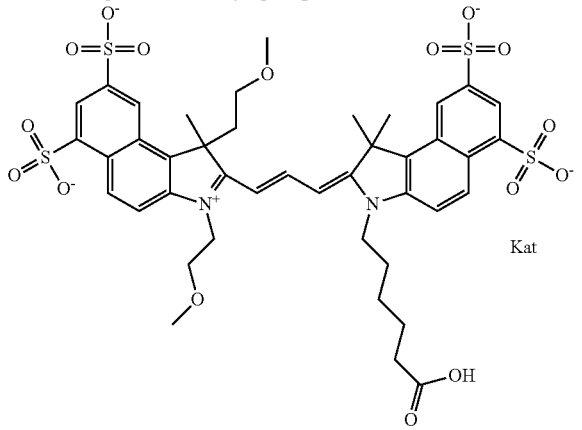


where each of R^1, R^2, R^5, and R^6 is the same or different and is independently selected from the group consisting of an aliphatic, heteroaliphatic, sulfoalkyl group, heteroaliphatic with terminal SO_3, a PEG group P—Z where P is selected from an ethylene glycol group, a diethylene glycol group, and a polyethylene glycol group, where the polyethylene glycol group is $(CH_2CH_2O)_s$, where s is an integer from 3-6 inclusive, a sulfonamide group -L-SO_2NH—P—Z, and a carboxamide group -L-CONH—P—Z, and Z is selected from H, CH_3, a CH_3 group, an alkyl group, a heteroalkyl group, or —CO—NHS; each of R^7, R^8, R^{11}, R^{12}, R^{13}, and R^{14} is the same or different and is independently selected from either H, SO_3, a PEG group P—Z where P is selected from an ethylene glycol group, a diethylene glycol group, and a polyethylene glycol group, where the polyethylene glycol group is $(CH_2CH_2O)_s$, where s is an integer from 3-6 inclusive, a sulfonamide group -L-SO_2NH—P—Z, or a carboxamide group -L-CONH—P—Z, and Z is selected from H, a CH_3 group, an alkyl group, or a heteroalkyl group; X is selected from the group consisting of —OH, —SH, —NH_2, —NH—NH_2, —F, —Cl, —Br, I, —NHS (hydroxysuccinimidyl/sulfosuccinimidyl), —O-TFP (2,3,5,6-tetrafluorophenoxy), —O-STP (4-sulfo-2,3,5,6-tetrafluorophenoxy), —O-benzotriazole, -benzotriazole, —NR-L-OH, —NR-L-O-phosphoramidite, —NR-L-SH, —NR-L-NH_2, —NR-L-NH—NH_2, —NR-L-CO_2H, —NR-L-CO—NHS, —NR-L-CO-STP, —NR-L-CO-TFP, —NR-L-CO-benzotriazole, —NR-L-CHO, —NR-L-maleimide, —NR-L-NH—CO—CH2-I, imidazole, azide, —NR-L-O—NH2, and —NR-L-O—CO—NHS, where R is —H or an aliphatic or heteroaliphatic group, and L is selected from the group consisting of a divalent linear (—$(CH_2)_t$—, t=0 to 15), crossed, or cyclic alkyl group optionally substituted by at least one oxygen atom and/or sulfur atom; Kat is a number of Na^+, K^+, Ca^{2+}, ammonia, or other cation(s) needed to compensate the negative charge brought by the cyanine; m is an integer from 0 to 5 inclusive; o is an integer from 0 to 12 inclusive; p is an integer from 1 to 6 inclusive; each of R3 and R4 is the same or different and is independently hydrogen, an aliphatic group, a heteroaliphatic group, or a PEG group P—Z where P is selected from an ethylene glycol group, a diethylene glycol group, and a polyethylene glycol group, where the polyethylene glycol group is $(CH_2CH_2O)_s$, where s is an integer from 3-6 inclusive, and Z is selected from H, a CH_3 group, an alkyl group, or a heteroalkyl group; or R3 and R4 together form a cyclic structure where R3 and R4 are joined using a divalent structural element selected from the group consisting of —$(CH_2)_q$—, —$(CH_2)_q$O$(CH_2)_{q'}$—, —$(CH_2)_q$S$(CH_2)_{q'}$—, —$(CH_2)_q$CH=CH—, and —OCH=CH— where each of q and q' is the same or different and is a integer from 2 to 6 inclusive; and Y is selected from the group consisting of hydrogen, alkyl, sulfoalkyl, fluorine, chlorine, bromine, a substituted or unsubstituted aryl-, phenoxy-, phenylmercapto function, and a PEG group P—Z where P is selected from an ethylene glycol group, a diethylene glycol group, and a polyethylene glycol group, where the polyethylene glycol group is $(CH_2CH_2O)_s$, where s is an integer from 3-6 inclusive, and Z is selected from H, CH_3, a CH_3 group, an alkyl group, or a heteroalkyl group.

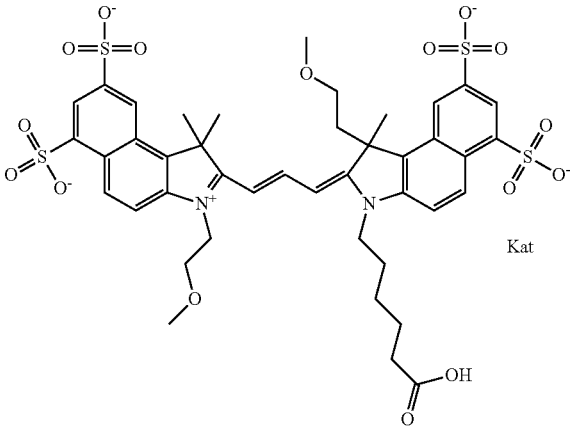
In one embodiment, the compound of general formula IV wherein each of R3 and R4 is the same or different and is independently hydrogen, an aliphatic group, or a heteroaliphatic group, or R3 and R4 together form a cyclic structure where R3 and R4 are directly joined or joined using a divalent structural element selected from the group consisting of —$(CH_2)_q$— and CH=CH, where q is an integer from 1 to 2 inclusive, to result in a 3-, 4-, or 5-membered ring.

In various embodiments, an ethylene glycol group, diethylene glycol group, and/or a polyethylene glycol group, which will collectively be referred to as a PEG group, unless specifically defined, may be present at position(s) in addition to such groups being present on the N atom(s) of the indole structure.

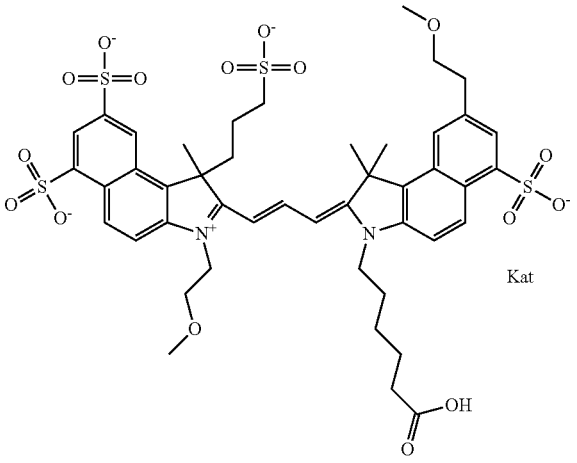
One non-limiting example of an additionally PEG-substituted compound is a 579 Compound 1/2 according to general formula II where R1 is an ethylene glycol group (PEG_1) terminating with a methyl group, shown below:



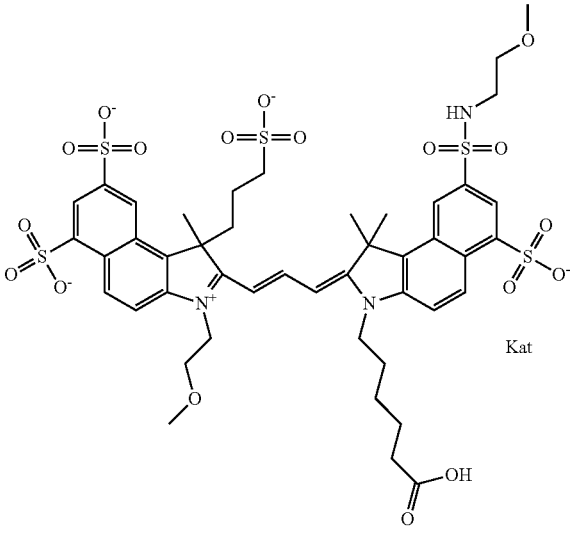
One non-limiting example of an additionally PEG-substituted compound is a 579 Compound 1/2 according to general formula II where R2 is an ethylene glycol group (PEG_1) terminating with a methyl group, shown below:



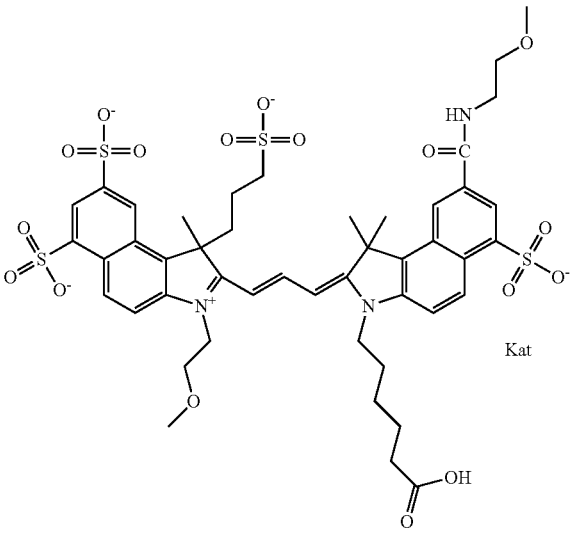
One non-limiting example of an additionally PEG-substituted compound is a 579 Compound 1/2 according to general formula II where R8 is an ethylene glycol group (PEG_1) terminating with a methyl group, shown below:



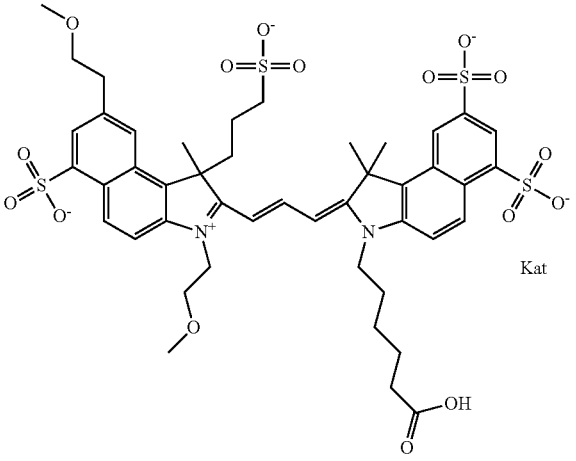
One non-limiting example of an additionally PEG-substituted compound is a 579 Compound 1/2 according to general formula II where R8 is a sulfonamide group with an ethylene glycol group (PEG_1) terminating with a methyl group, shown below:



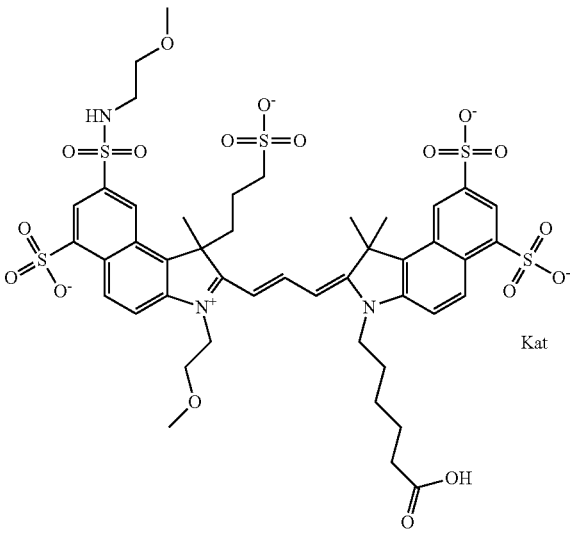
One non-limiting example of an additionally PEG-substituted compound is a 579 Compound 1/2 according to general formula II where R8 is a carboxamide group with an ethylene glycol group (PEG_1) terminating with a methyl group, shown below:



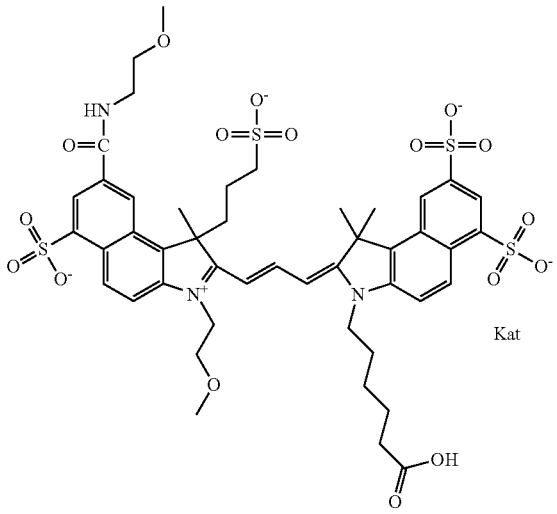
One non-limiting example of an additionally PEG-substituted compound is a 579 Compound 1/2 according to general formula II where R7 is an ethylene glycol group (PEG_1) terminating with a methyl group, shown below:



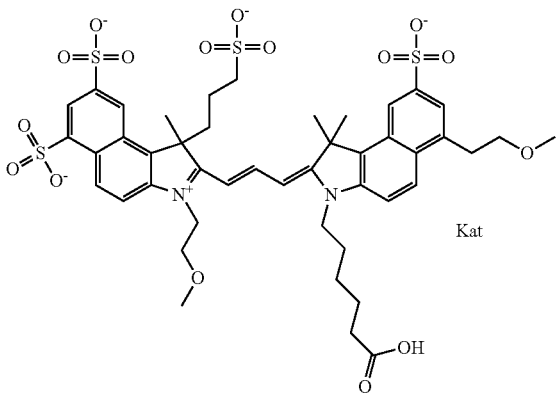
One non-limiting example of an additionally PEG-substituted compound is a 579 Compound 1/2 according to general formula II where R7 is a sulfonamide group with an ethylene glycol group (PEG_1) terminating with a methyl group, shown below:



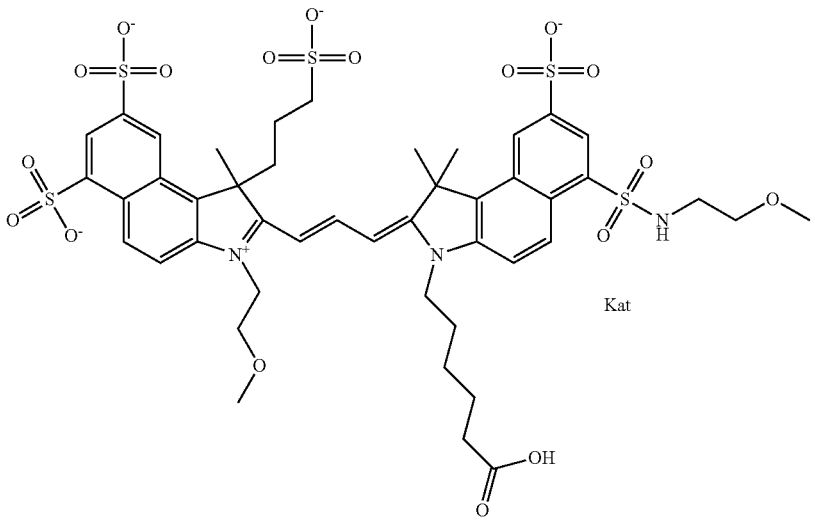
One non-limiting example of an additionally PEG-substituted compound is a 579 Compound 1/2 according to general formula II where R7 is a carboxamide group with an ethylene glycol group (PEG_1) terminating with a methyl group, shown below:



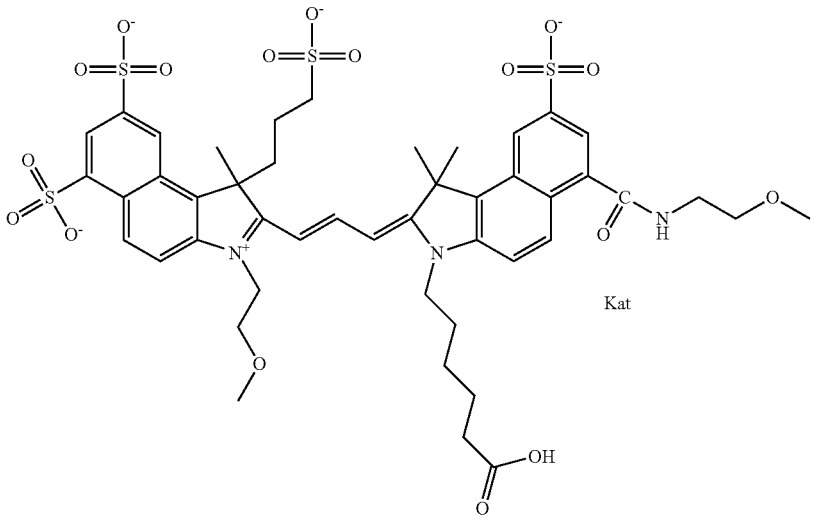
One non-limiting example of an additionally PEG-substituted compound is a 579 Compound 1/2 according to general formula II where R12 is an ethylene glycol group terminating with a methyl group, shown below:



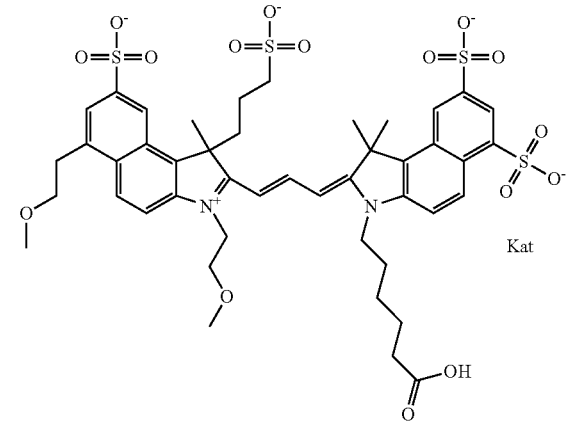
One non-limiting example of an additionally PEG-substituted compound is a 579 Compound 1/2 according to general formula II where R12 is a sulfonamide group with an ethylene glycol group (PEG_1) terminating with a methyl group, shown below:



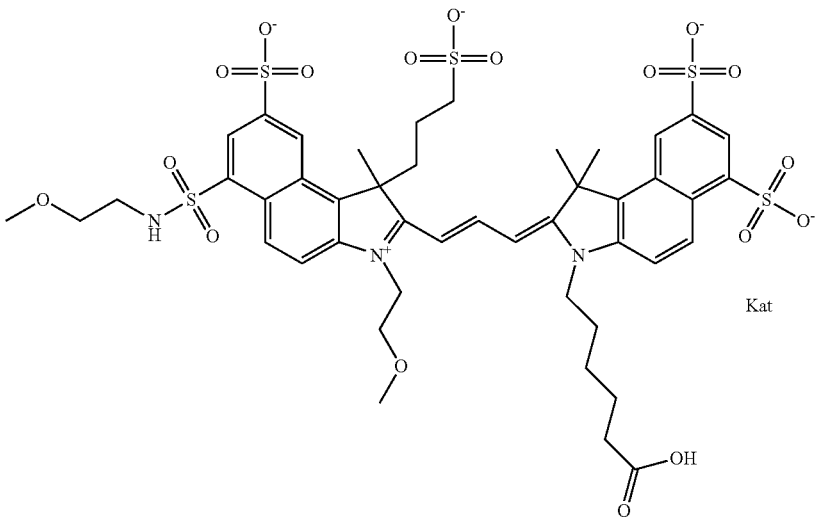
One non-limiting example of an additionally PEG-substituted compound is a 579 Compound 1/2 according to general formula II where R12 is a carboxamide group with an ethylene glycol group (PEG_1) terminating with a methyl group, shown below:



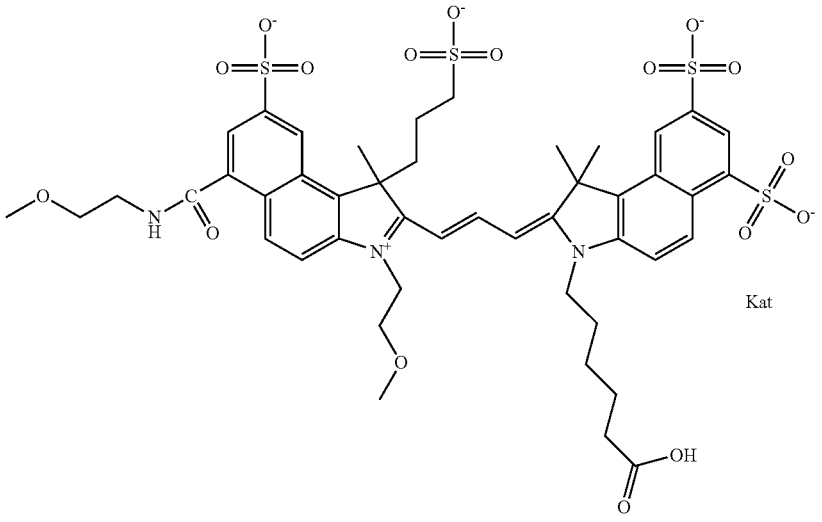
One non-limiting example of an additionally PEG-substituted compound is a 579 Compound 1/2 according to general formula II where R11 is an ethylene glycol group terminating with a methyl group, shown below:



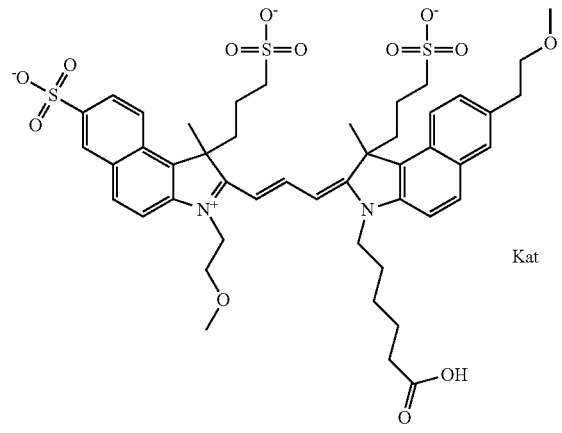
One non-limiting example of an additionally PEG-substituted compound is a 579 Compound 1/2 according to general formula II where R11 is a sulfonamide group with an ethylene glycol group (PEG_1) terminating with a methyl group, shown below:



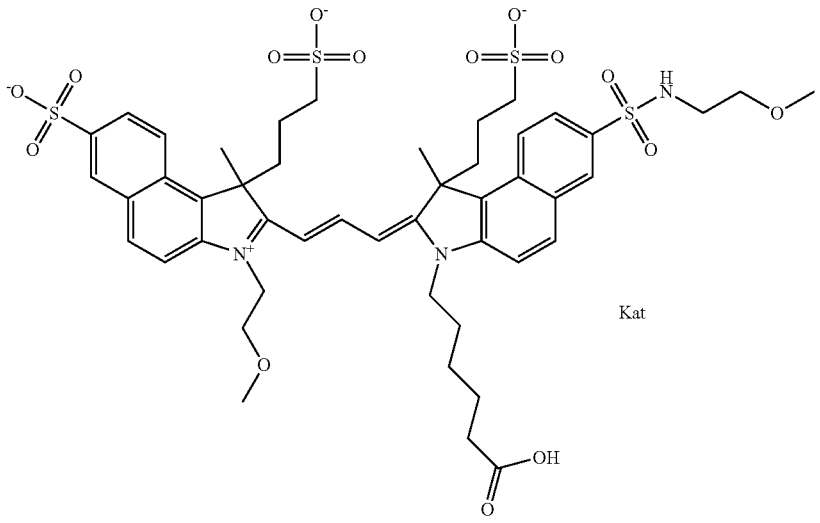
One non-limiting example of an additionally PEG-substituted compound is a 579 Compound 1/2 according to general formula II where R11 is a carboxamide group with an ethylene glycol group (PEG_1) terminating with a methyl group, shown below:



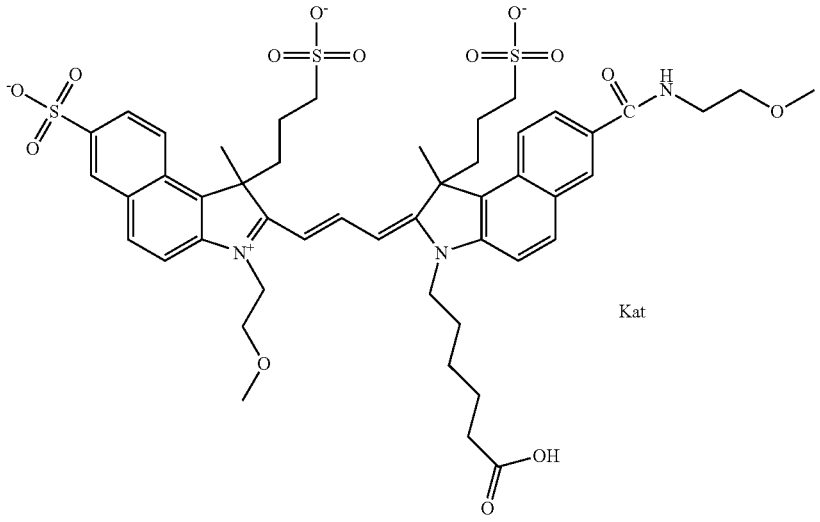
One non-limiting example of an additionally PEG-substituted compound is a 579 Compound 1/2 according to general formula II where R14 is an ethylene glycol group terminating with a methyl group, shown below:



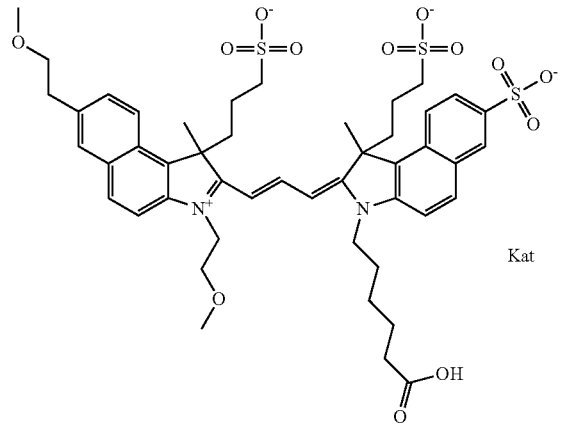
One non-limiting example of an additionally PEG-substituted compound is a 579 Compound 1/2 according to general formula II where R14 is a sulfonamide group with an ethylene glycol group (PEG_1) terminating with a methyl group, shown below:



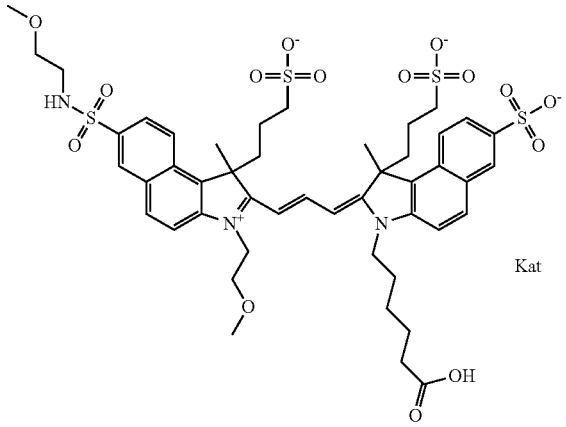
One non-limiting example of an additionally PEG-substituted compound is a 579 Compound 1/2 according to general formula II where R14 is a carboxamide group with an ethylene glycol group (PEG terminating with a methyl group, shown below:



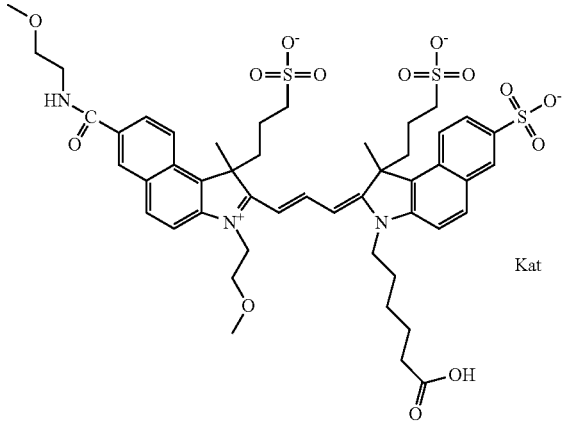
One non-limiting example of an additionally PEG-substituted compound is a 579 Compound 1/2 according to general formula II where R13 is an ethylene glycol group terminating with a methyl group, shown below:



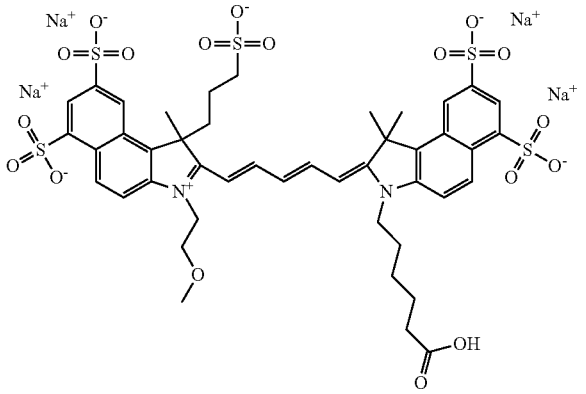
One non-limiting example of an additionally PEG-substituted compound is a 579 Compound 1/2 according to general formula II where R13 is a sulfonamide group with an ethylene glycol group (PEG_1) terminating with a methyl group, shown below:



One non-limiting example of an additionally PEG-substituted compound is a 579 Compound 1/2 according to general formula II where R13 is a carboxamide group with an ethylene glycol group (PEG_1) terminating with a methyl group, shown below:

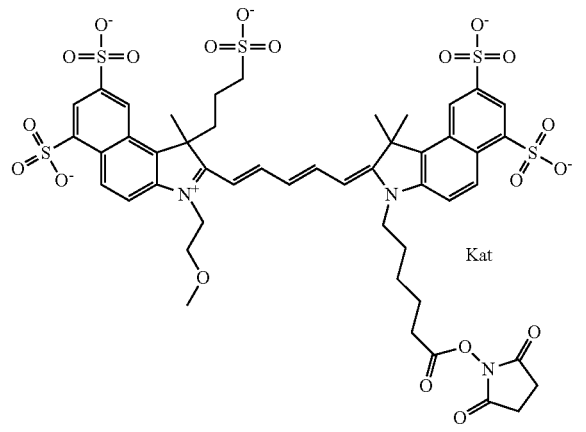


In one embodiment, the compound is 679 Compound 1

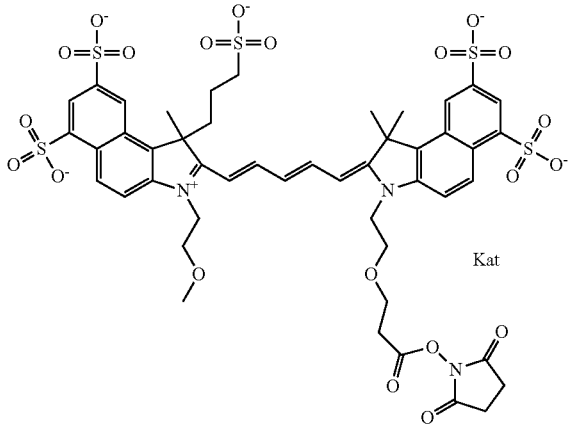


679 Compound 1 (6-((E)-2-(2E,4E)-5-(3-(2-methoxyethyl)-1-methyl-6,8-disulfonato-1-(3-sulfonatopropyl)-1H-benzo[e]indol-3-ium-2-yl)penta-2,4-dien-1-ylidene)-1,1-dimethyl-6,8-disulfonato-1H-benzo[e]indol-3(2H)-yl) hexanoate) contains an ethylene glycol on the indole N of the left heterocycle, i.e., a methylated ethylene glycol. The methyl group on the ethylene glycol prevents the terminal —OH from oxidation. Oxidation is known to occur, over time, on an unprotected PEG terminus. Adding a methyl ether provides this protection, and prevents reaction with electrophilic reactive groups.

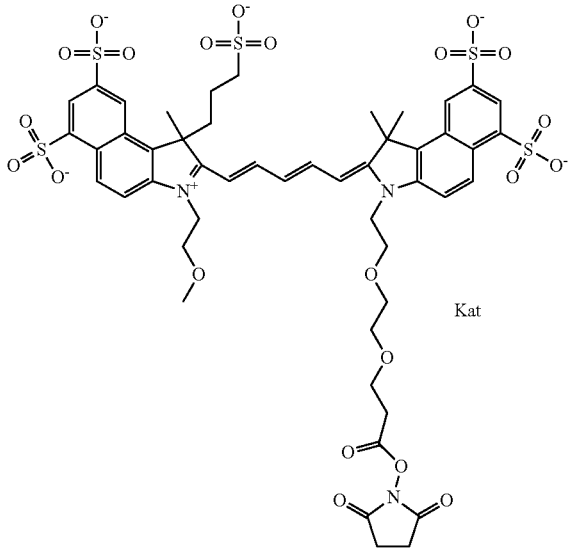
In embodiments, e.g., for functional assays, the inventive compounds are activated. Activation of the compound adds a chemical moiety such that the compound is in a form that can be conjugated to a biological moiety. Examples of chemical moieties for activation are described below with reference to activation of 679 Compound 1, but one skilled in the art appreciates that activation is not limited to these examples. One non-limiting example of an activated compound is the NHS-ester of 679 Compound 1, shown below:



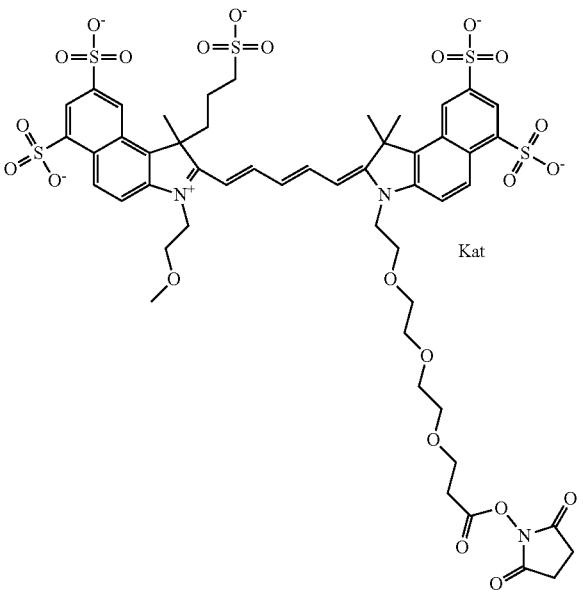
One non-limiting example of a NHS-ester of 679 Compound 1, according to general formula III, where m=1 and p=1, is shown below:



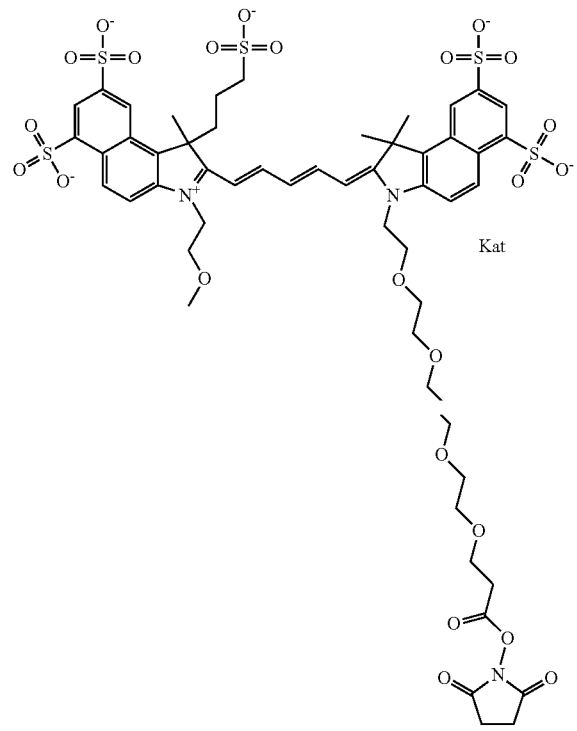
One non-limiting example of a NHS-ester of 679 Compound 1, according to general formula III, where m=1 and p=2, is shown below:



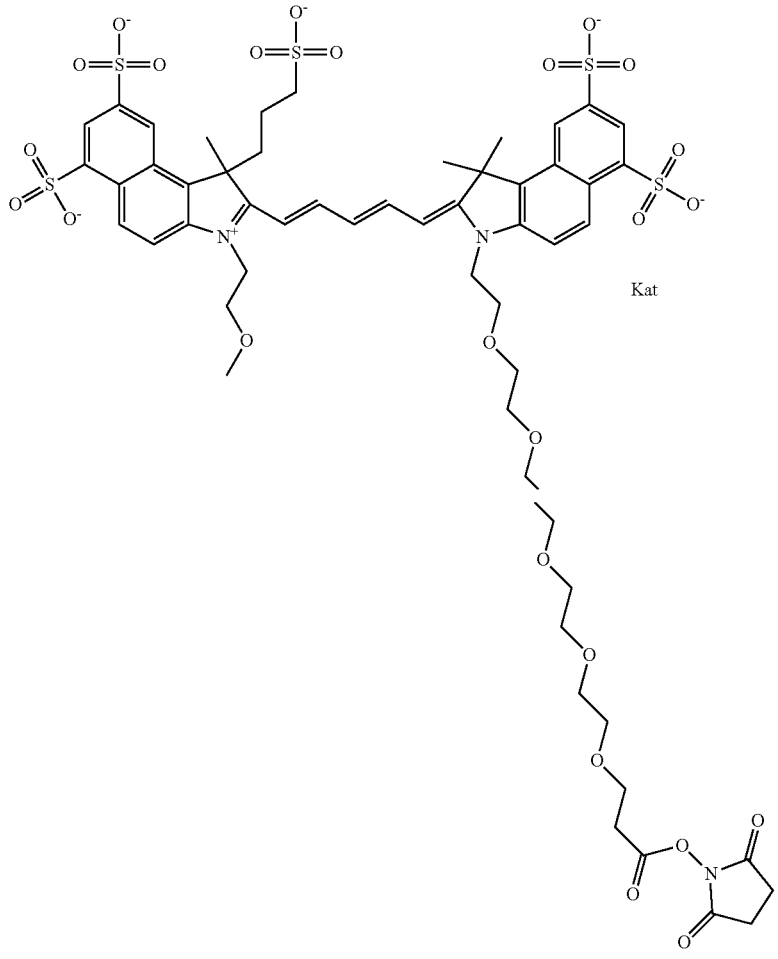
One non-limiting example of a NHS-ester of 679 Compound 1, according to general formula III, where m=1 and p=3, is shown below:



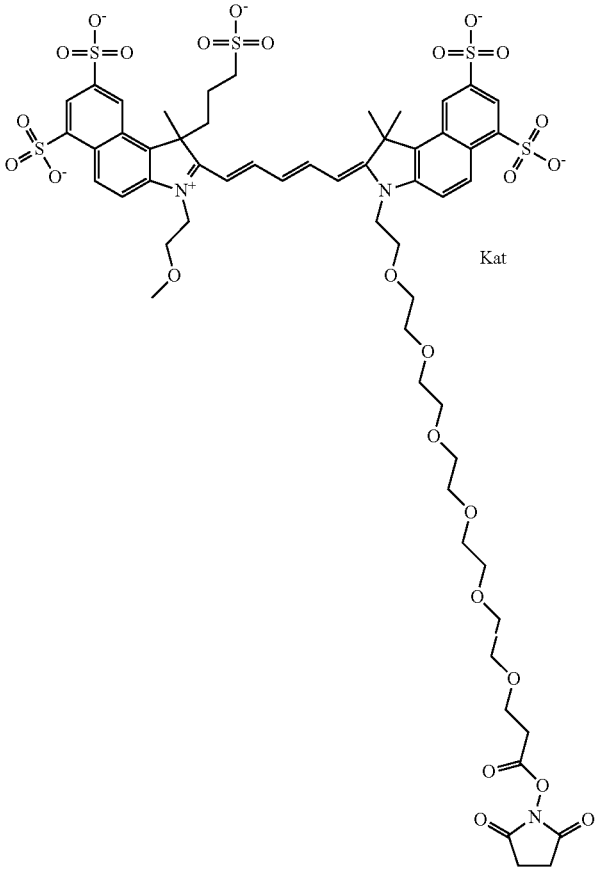
One non-limiting example of a NHS-ester of 679 Compound 1, according to general formula III, where m=1 and p=4, is shown below:



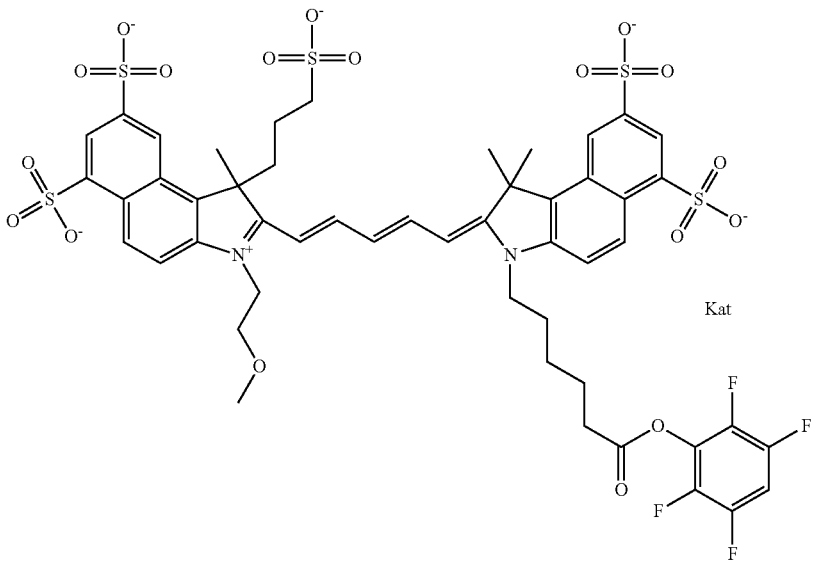
One non-limiting example of a NHS-ester of 679 Compound 1, according to general formula III, where m=1 and p=5, is shown below:



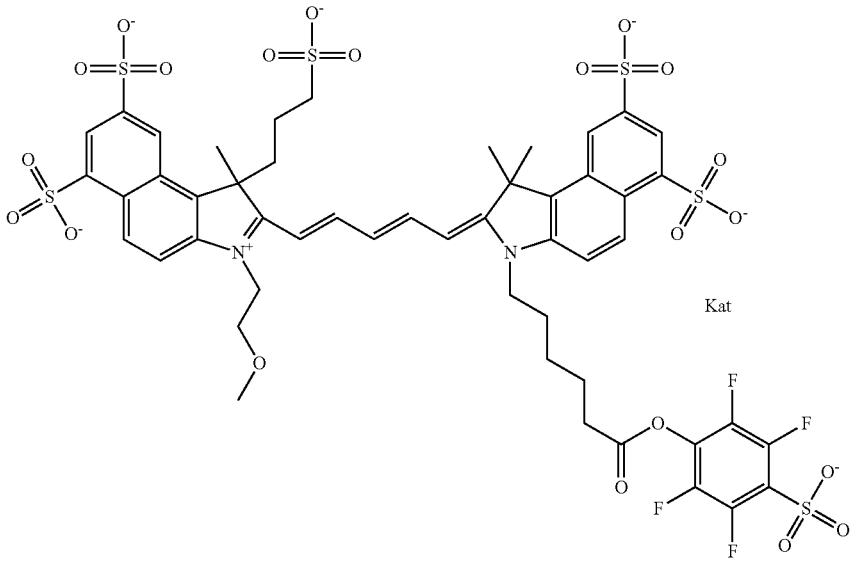
One non-limiting example of a NHS-ester of 679 Compound 1, according to general formula III, where m=1 and p=6, is shown below:



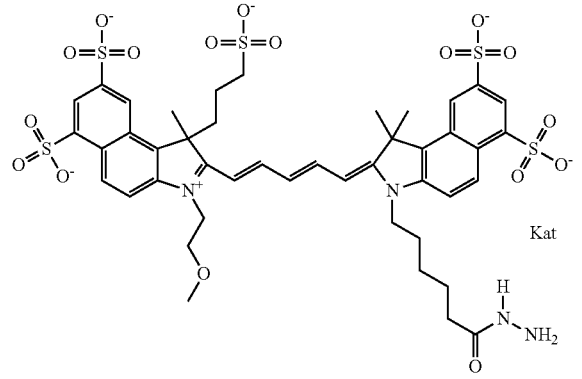
One non-limiting example of an activated 679 Compound 1 is a tetrafluorophenyl (TFP)-ester form of 679 Compound 1, shown below:



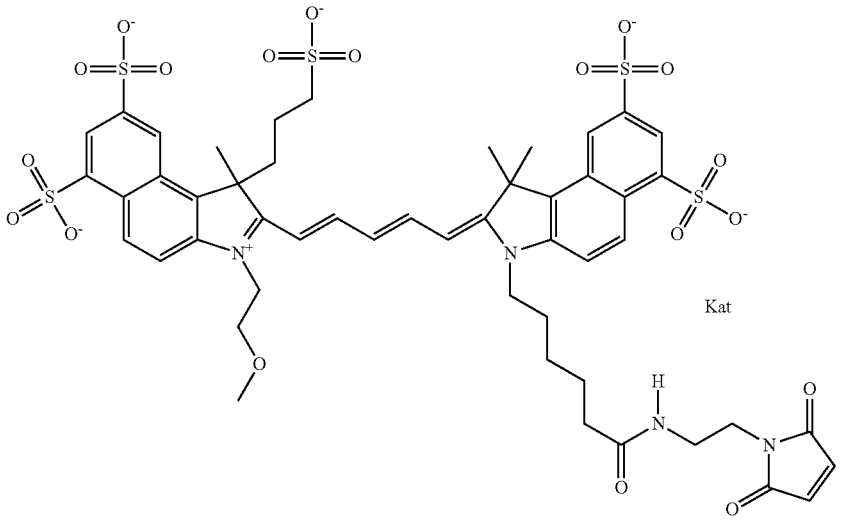
One non-limiting example of an activated 679 Compound 1 is a sulfotetrafluorophenyl (STP)-ester form of 679 Compound 1, shown below:



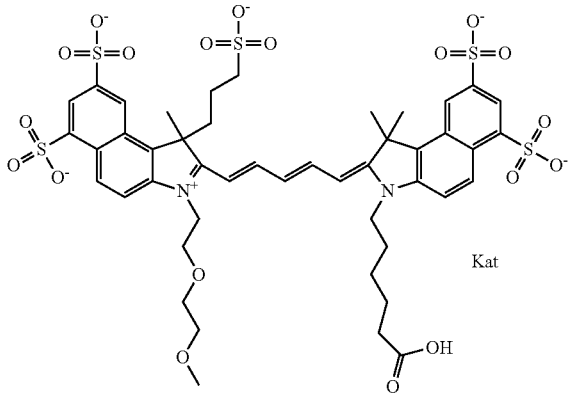
One non-limiting example of an activated 679 Compound 1 is a hydrazide form of 679 Compound 1, shown below:



One non-limiting example of an activated 679 Compound 1 is a maleimide form of 679 Compound 1, shown below:

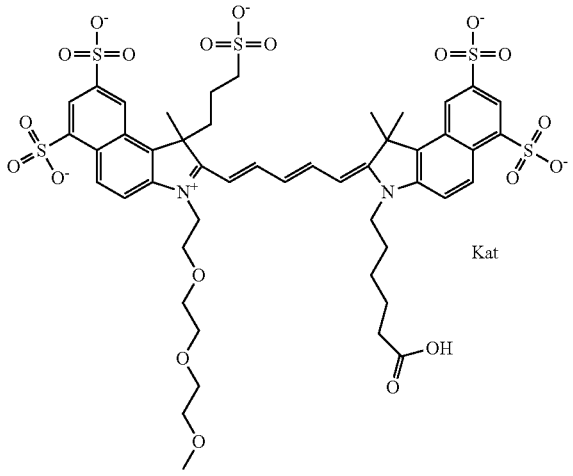


In one embodiment, the compound is 679 Compound 2



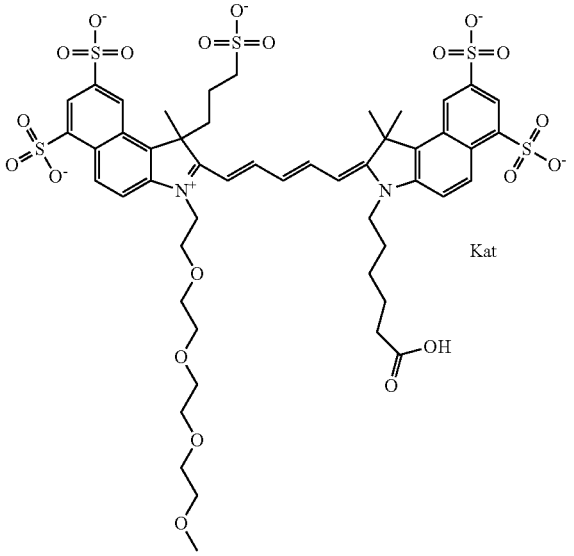
679 Compound 2 (6-((E)-2-((2E,4E)-5-(3-(2-(2-methoxyethoxy)ethyl)-1-methyl-6,8-disulfonato-1-(3-sulfonatopropyl)-1H-benzo[e]indol-3-ium-2-yl)penta-2,4-dien-1-ylidene)-1,1-dimethyl-6,8-disulfonato-1H-benzo[e]indol-3(2H)-yl)hexanoate) contains a diethylene glycol on the indole N of the left heterocycle. The methyl group on the ethylene glycol prevents the terminal —OH from oxidation. Oxidation is known to occur, over time, on an unprotected PEG terminus. Adding a methyl ether provides this protection, and prevents reaction with electrophilic reactive groups. For functional assays, 679 Compound 2 is activated as described above.

In one embodiment, the compound is 679 Compound 3



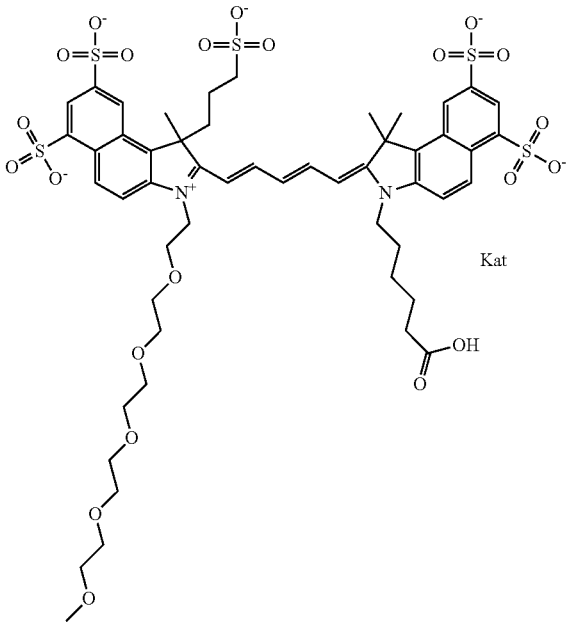
679 Compound 3 (6-((E)-2-((2E,4E)-5-(3-(2-(2-(2-methoxyethoxy)ethoxy)ethyl)-1-methyl-6,8-disulfonato-1-(3-sulfonatopropyl)-1H-benzo[e]indol-3-ium-2-yl)penta-2,4-dien-1-ylidene)-1,1-dimethyl-6,8-disulfonato-1H-benzo[e]indol-3(2H)-yl)hexanoate) contains a (poly)ethylene glycol on the indole N of the left heterocycle. The methyl group on the ethylene glycol prevents the terminal —OH from oxidation. Oxidation is known to occur, over time, on an unprotected PEG terminus. Adding a methyl ether provides this protection, and prevents reaction with electrophilic reactive groups. For functional assays, 679 Compound 3 is activated as described above.

In one embodiment, the compound is 679 Compound 4



679 Compound 4 (6-((E)-1,1-dimethyl-2-((2E,4E)-5-(1-methyl-6,8-disulfonato-1-(3-sulfonatopropyl)-3-(2,5,8,11-tetraoxatridecan-13-yl)-1H-benzo[e]indol-3-ium-2-yl)penta-2,4-dien-1-ylidene)-6,8-disulfonato-1H-benzo[e]indol-3(2H)-yl)hexanoate) contains a (poly)ethylene glycol on the indole N of the left heterocycle. The methyl group on the ethylene glycol prevents the terminal —OH from oxidation. Oxidation is known to occur, over time, on an unprotected PEG terminus. Adding a methyl ether provides this protection, and prevents reaction with electrophilic reactive groups. For functional assays, 679 Compound 4 is activated as described above.

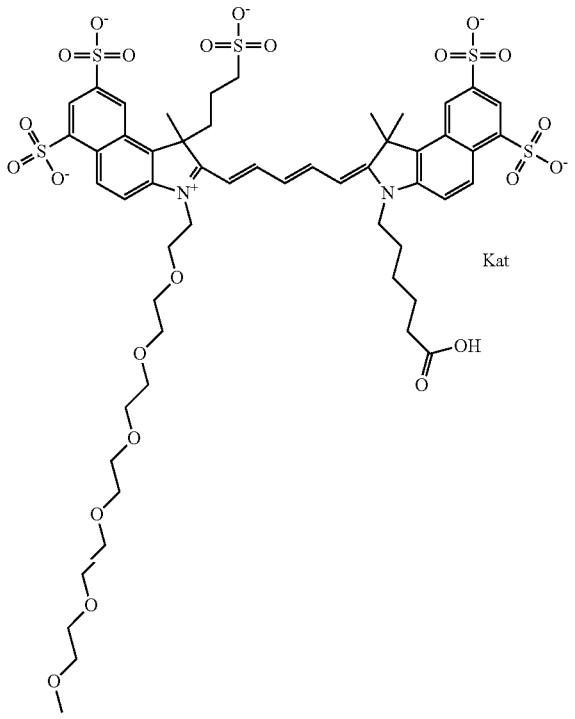
In one embodiment, the compound is 679 Compound 5



679 Compound 5 (6-((E)-2-((2E,4E)-5-(3-(2,5,8,11,14-pentaoxahexadecan-16-yl)-1-methyl-6,8-disulfonato-1-(3-

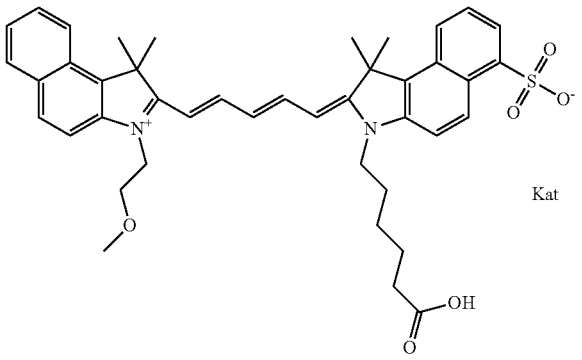
sulfonatopropyl)-1H-benzo[e]indol-3-ium-2-yl)penta-2,4-dien-1-ylidene)-1,1-dimethyl-6,8-disulfonato-1H-benzo[e]indol-3(2H)-yl)hexanoate) contains a (poly)ethylene glycol on the indole N of the left heterocycle. The methyl group on the ethylene glycol prevents the terminal —OH from oxidation. Oxidation is known to occur, over time, on an unprotected PEG terminus. Adding a methyl ether provides this protection, and prevents reaction with electrophilic reactive groups. For functional assays, 679 Compound 5 is activated as described above.

In one embodiment, the compound is 679 Compound 6

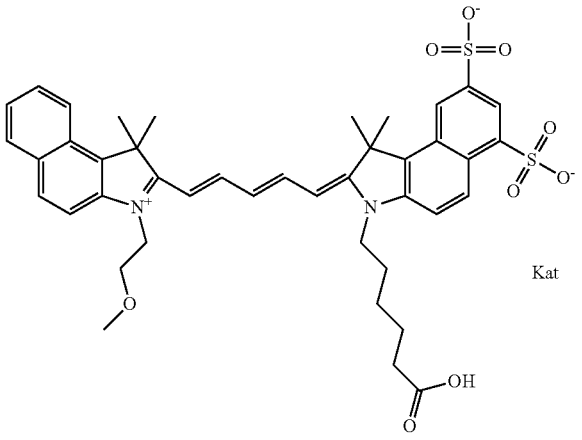


679 Compound 6 (6-((E)-1,1-dimethyl-2-((2E,4E)-5-(1-methyl-3-(2,5,8,11,14,17-hexaoxanonadecan-19-yl)-6,8-disulfonato-1-(3-sulfonatopropyl)-1H-benzo[e]indol-3-ium-2-yl)penta-2,4-dien-1-ylidene)-6,8-disulfonato-1H-benzo[e]indol-3(2H)-yl)hexanoate) contains a (poly)ethylene glycol on the indole N of the left heterocycle. The methyl group on the ethylene glycol prevents the terminal —OH from oxidation. Oxidation is known to occur, over time, on an unprotected PEG terminus. Adding a methyl ether provides this protection, and prevents reaction with electrophilic reactive groups. For functional assays, 649 Compound 6 is activated as described above.

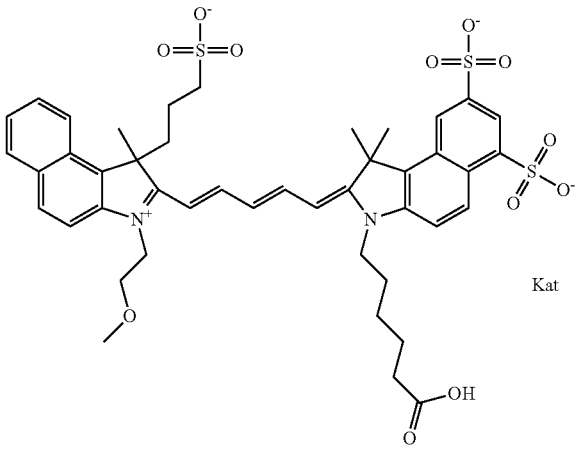
In embodiments, the degree and/or location of sulfonation is varied to, e.g., vary the compound's degree of hydrophilicity or hydrophobicity. One non-limiting example is a monosulfonate form of 679 Compound 1, shown below:



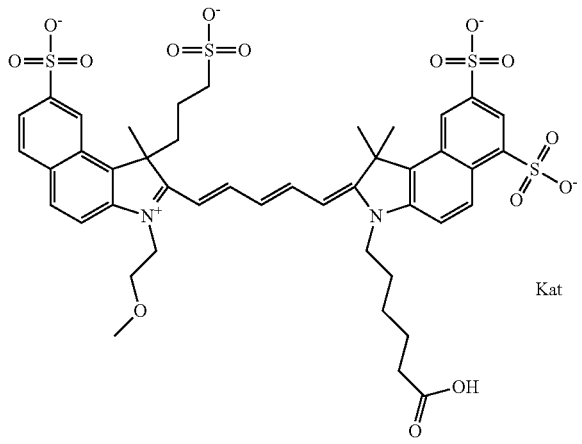
One non-limiting example is a disulfonate form of 679 Compound 1, shown below:



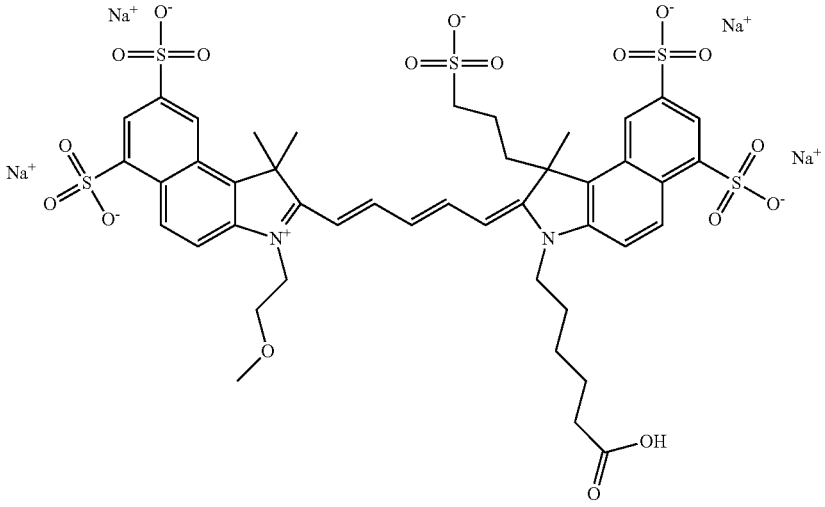
One non-limiting example is a trisulfonate form of 679 Compound 1, shown below:



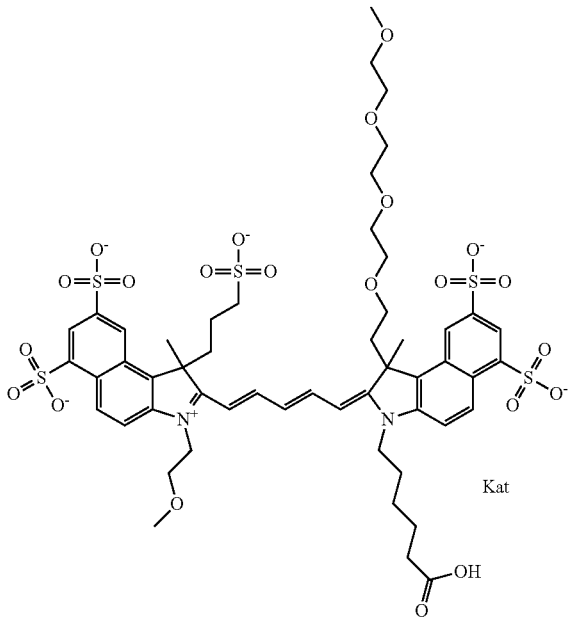
One non-limiting example is a tetrasulfonate form of 679 Compound 1, shown below:



One non-limiting example is a pentasulfonate form of 679 Compound 1, shown below:

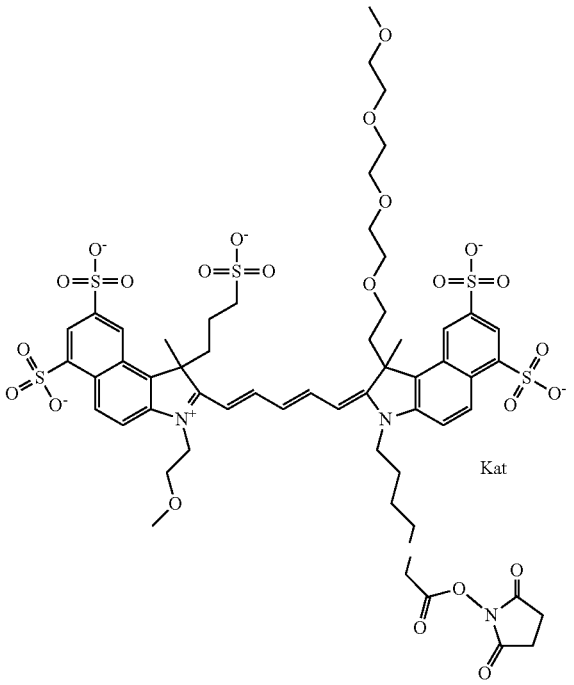


In one embodiment, the compound is 679 Compound 1/2 (PEG_4)

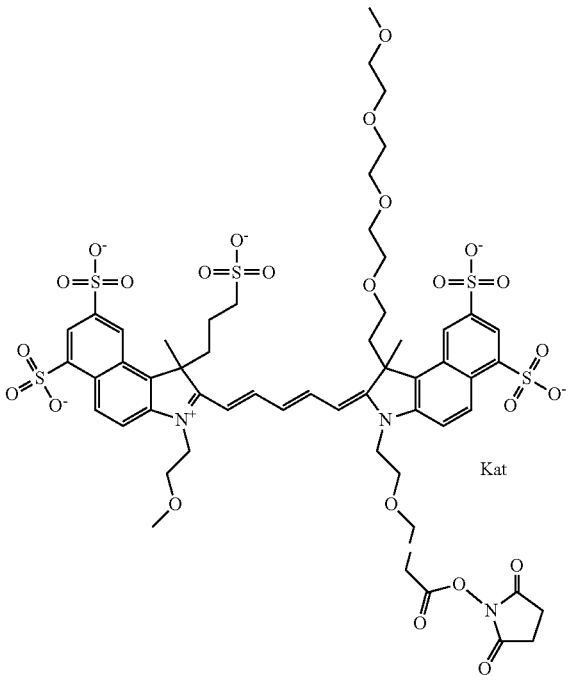


One non-limiting example of 679 Compound 1/2 (PEG_4) (2-((1E,3E,5E)-5-(3-(5-carboxypentyl)-1-methyl-6,8-disulfonato-1-(2,5,8,11-tetraoxatridecan-13-yl)-1H-benzo[e]indol-2(3H)-ylidene)penta-1,3-dienyl)-3-(2-methoxyethyl)-1-methyl-1-(3-sulfonatopropyl)-1H-benzo[e]indolium-6,8-disulfonate) contains an ethylene glycol on the indole N of the left heterocycle, i.e., a methylated ethylene glycol, and a PEG_4 group on the indole C. The methyl group on the ethylene glycol prevents the terminal —OH from oxidation. Oxidation is known to occur, over time, on an unprotected PEG terminus. Adding a methyl ether provides this protection, and prevents reaction with electrophilic reactive groups.

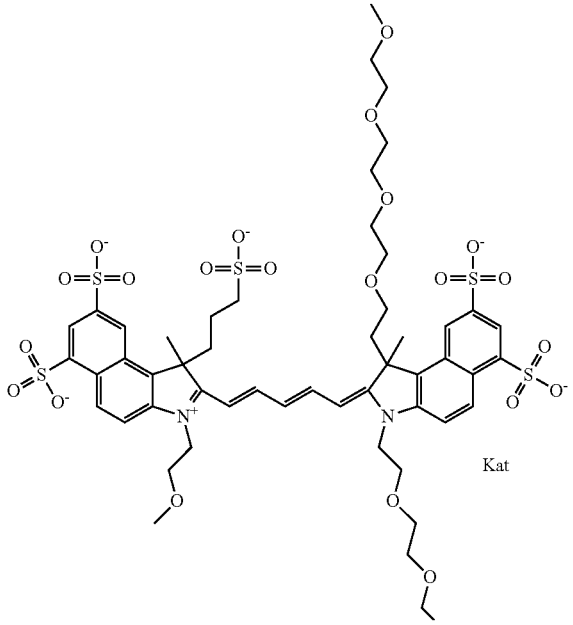
In embodiments, e.g., for functional assays, the inventive compounds are activated. Activation of the compound adds a chemical moiety such that the compound is in a form that can be conjugated to a biological moiety. Examples of chemical moieties for activation are described below with reference to activation of 679 Compound 1/2 (PEG_4), but one skilled in the art appreciates that activation is not limited to these examples. One non-limiting example of an activated compound is the NHS-ester of 679 Compound 1/2 (PEG_4), shown below:

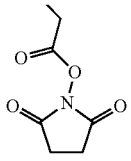


One non-limiting example of a NHS-ester of 679 Compound 1/3 (PEG_4), according to general formula III, where m=1 and p=1, is shown below:

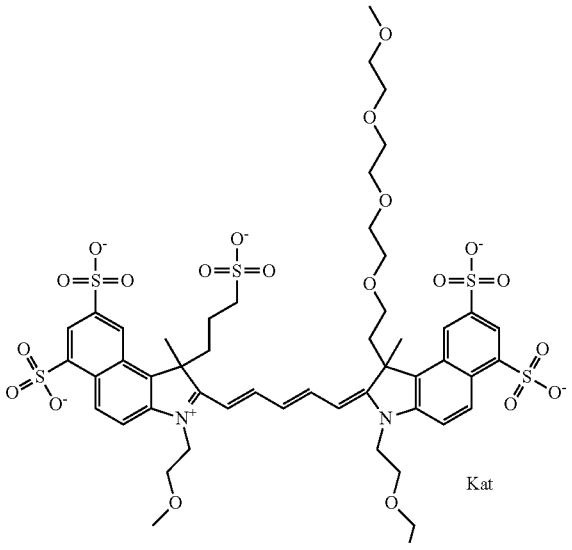


One non-limiting example of a NHS-ester of 679 Compound 1/3 (PEG_4), according to general formula III, where m=1 and p=2, is shown below:





One non-limiting example of a NHS-ester of 679 Compound 1/3 (PEG_4), according to general formula III, where m=1 and p=3, is shown below:



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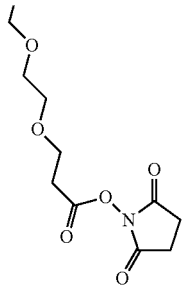
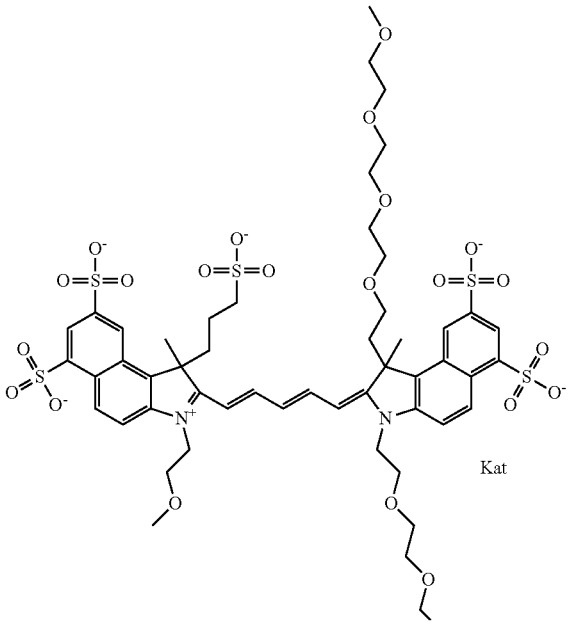
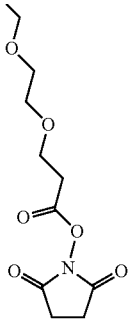
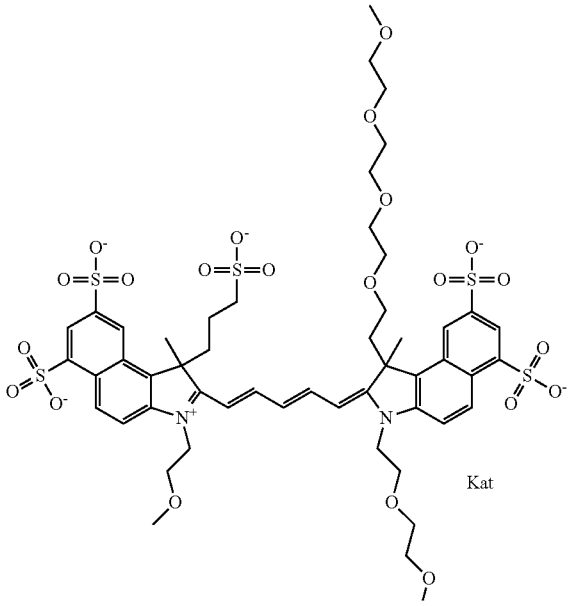


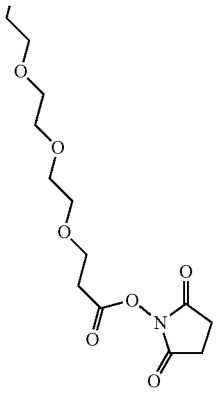
One non-limiting example of a NHS-ester of 679 Compound 1/3 (PEG_4), according to general formula III, where m=1 and p=4, is shown below:



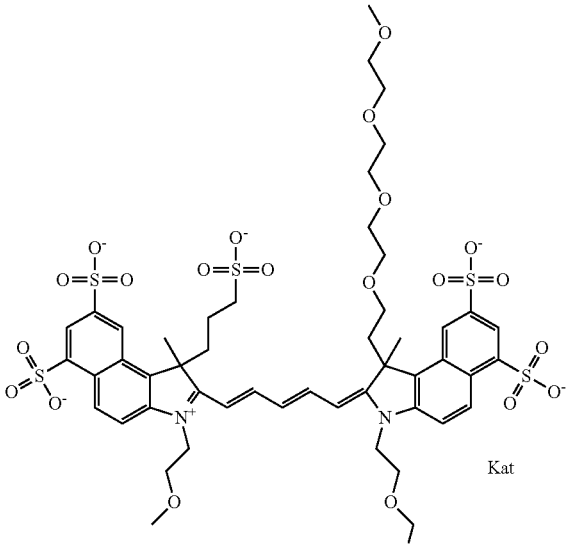


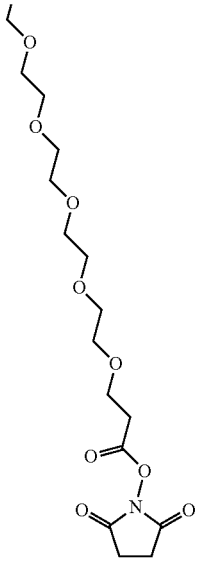
One non-limiting example of a NHS-ester of 679 Compound 1/3 (PEG_4), according to general formula III, where m=1 and p=5, is shown below:





One non-limiting example of a NHS-ester of 679 Compound 1/3 (PEG_4), according to general formula III, where m=1 and p=6, is shown below:





One non-limiting example of an activated 679 Compound 1/2 (PEG_4) is a tetrafluorophenyl (TFP)-ester form of 679 Compound 1, shown below:

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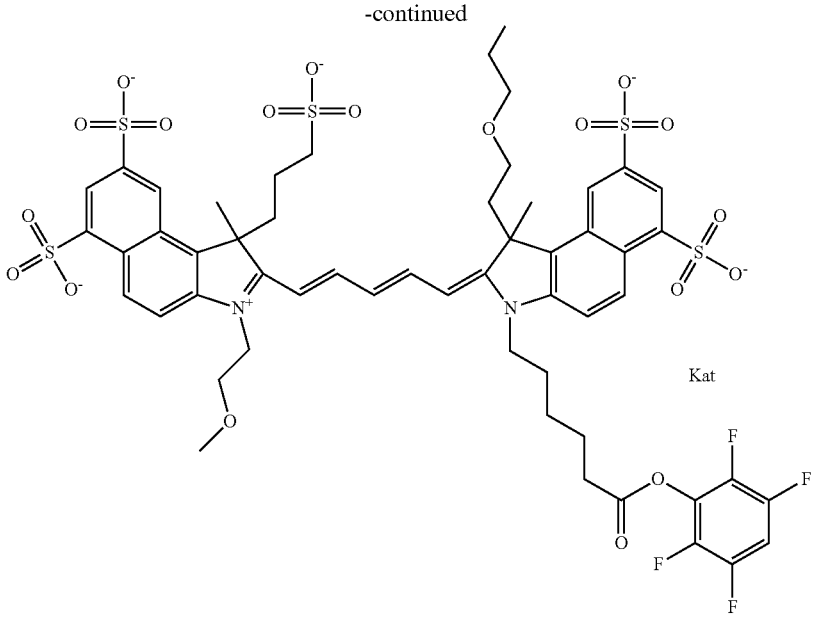
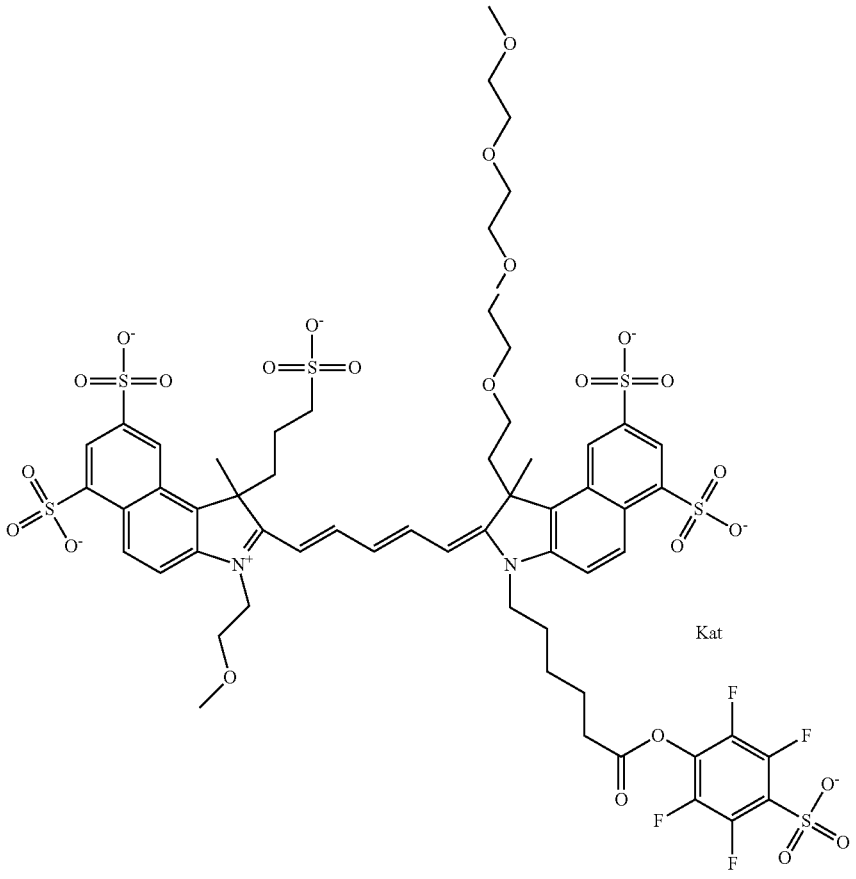
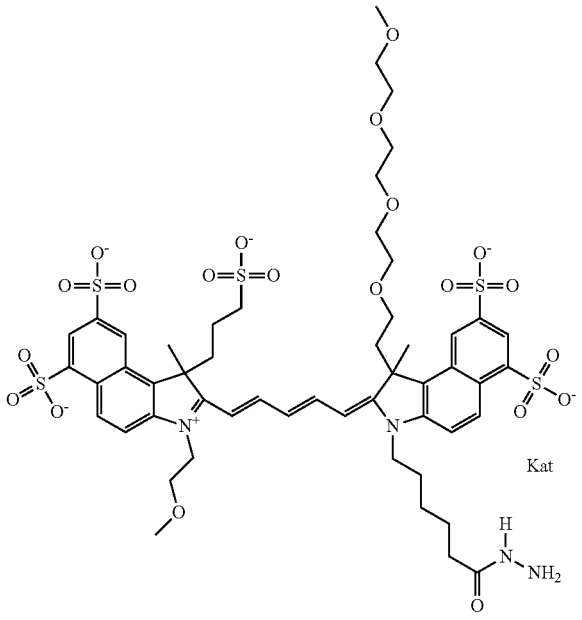


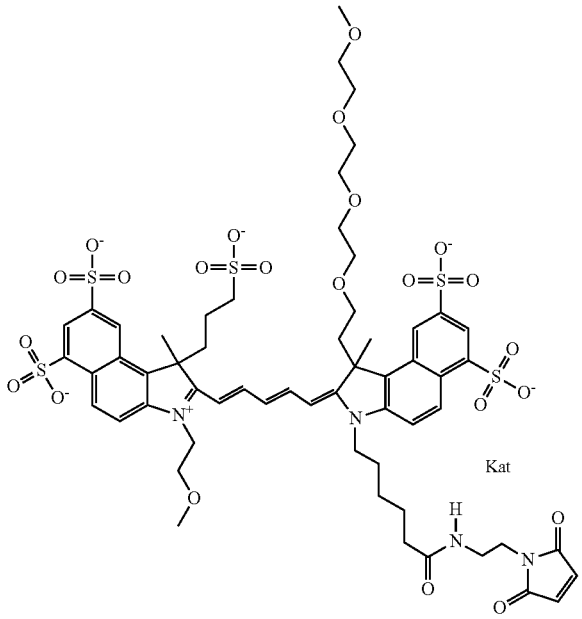
One non-limiting example of an activated 679 Compound 1/2 (PEG_4) is a sulfotetrafluorophenyl (STP)-ester form of 679 Compound 1, shown below:



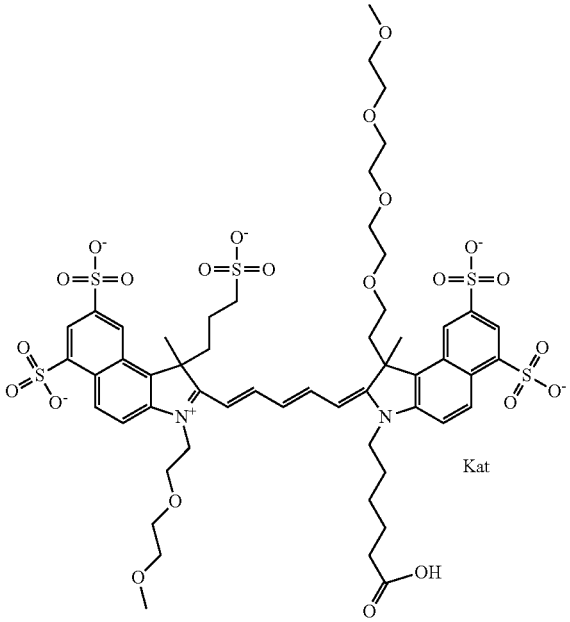
One non-limiting example of an activated 679 Compound 1/2 (PEG_4) is a hydrazide form of 679 Compound 1, shown below:



One non-limiting example of an activated 679 Compound 1/2 (PEG_4) is a maleimide form of 679 Compound 1, shown below:

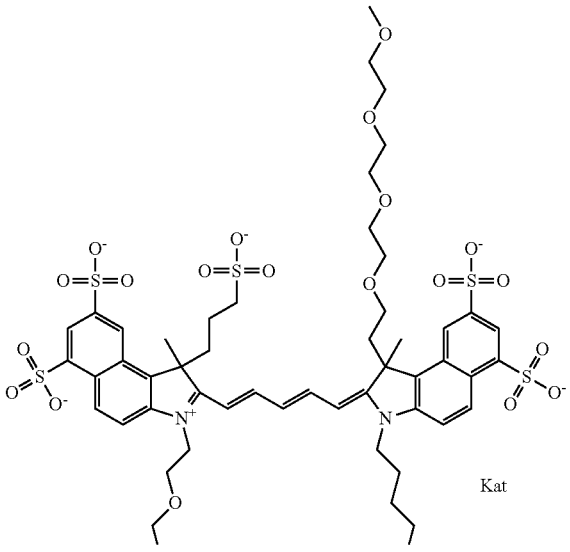


In one embodiment, the compound is 679 Compound 2/2 (PEG_4)

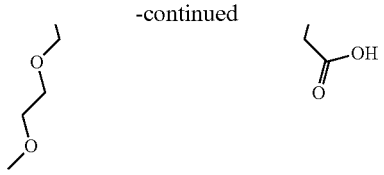


One non-limiting example of 679 Compound 2/2 (PEG_4) (2-((1E,3E,5E)-5-(3-(5-carboxypentyl)-1-methyl-6,8-disulfonato-1-(2,5,8,11-tetraoxatridecan-13-yl)-1H-benzo[e]indol-2(3H)-ylidene)penta-1,3-dienyl)-3-(2-(2-methoxyethoxy)ethyl)-1-methyl-1-(3-sulfonatopropyl)-1H-benzo[e]indolium-6,8-disulfonate) contains a diethylene glycol on the indole N of the left heterocycle and a PEG_4 group on the indole C. The methyl group on the ethylene glycol prevents the terminal —OH from oxidation. Oxidation is known to occur, over time, on an unprotected PEG terminus. Adding a methyl ether provides this protection, and prevents reaction with electrophilic reactive groups. For functional assays, 679 Compound 2/2 (PEG_4) is activated as described above.

In one embodiment, the compound is 679 Compound 3/2 (PEG_4)

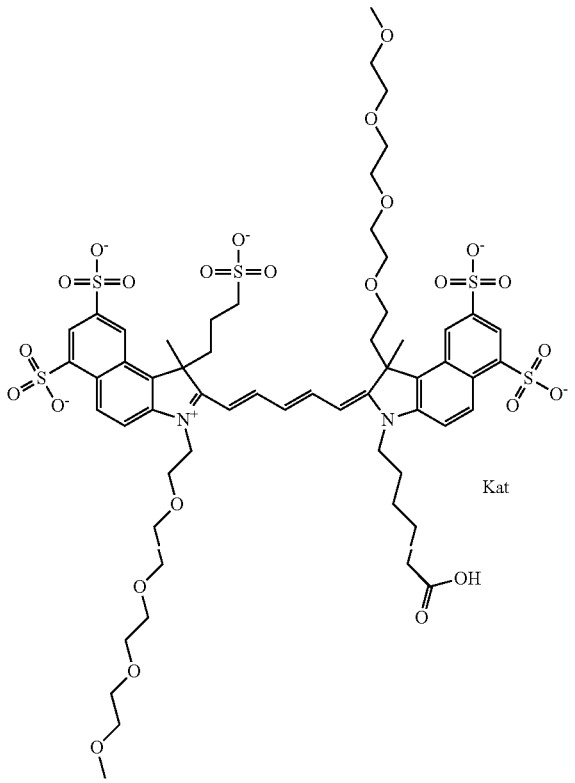


-continued



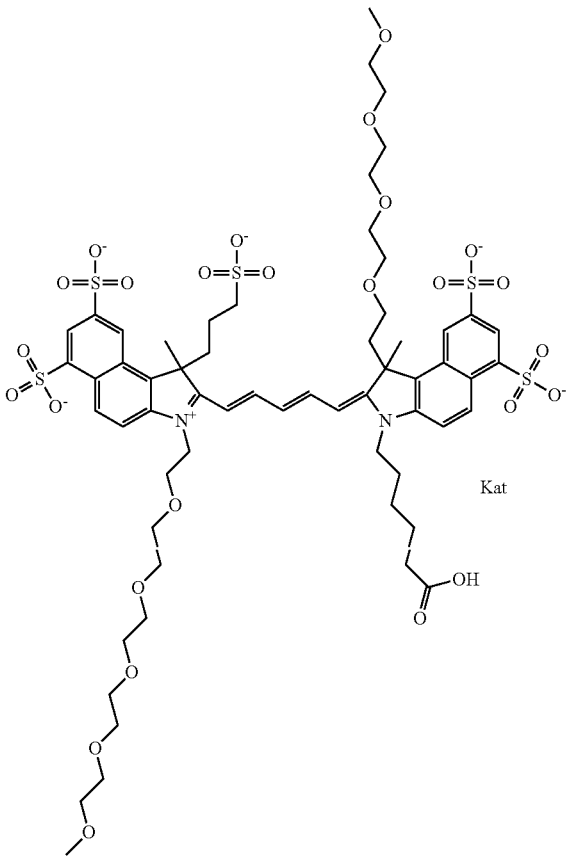
One non-limiting example of 679 Compound 3/2 (PEG_4) (2-((1E,3E,5E)-5-(3-(5-carboxypentyl)-1-methyl-6,8-disulfonato-1-(2,5,8,11-tetraoxatridecan-13-yl)-1H-benzo[e]indol-2(3H)-ylidene)penta-1,3-dienyl)-3-(2-(2-(2-methoxyethoxy)ethoxy)ethyl)-1-methyl-1-(3-sulfonatopropyl)-1H-benzo[e]indolium-6,8-disulfonate) contains a (poly)ethylene glycol on the indole N of the left heterocycle and a PEG_4 group on the indole C. The methyl group on the ethylene glycol prevents the terminal —OH from oxidation. Oxidation is known to occur, over time, on an unprotected PEG terminus. Adding a methyl ether provides this protection, and prevents reaction with electrophilic reactive groups. For functional assays, 679 Compound 3/2 (PEG_4) is activated as described above.

In one embodiment, the compound is 679 Compound 4/2 (PEG_4)



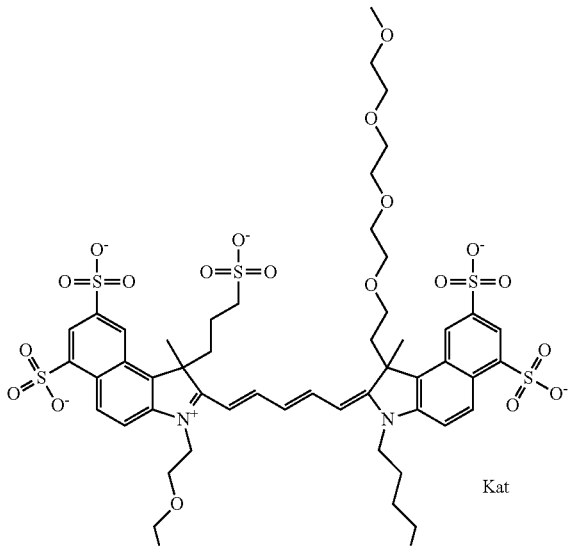
One non-limiting example of 679 Compound 4/2 (PEG_4) (2-((1E,3E,5E)-5-(3-(5-carboxypentyl)-1-methyl-6,8-disulfonato-1-(2,5,8,11-tetraoxatridecan-13-yl)-1H-benzo[e]indol-2(3H)-ylidene)penta-1,3-dienyl)-1-methyl-1-(3-sulfonatopropyl)-3-(2,5,8,11-tetraoxatridecan-13-yl)-1H-benzo[e]indolium-6,8-disulfonate) contains a (poly)ethylene glycol on the indole N of the left heterocycle and a PEG_4 group on the indole C. The methyl group on the ethylene glycol prevents the terminal —OH from oxidation. Oxidation is known to occur, over time, on an unprotected PEG terminus. Adding a methyl ether provides this protection, and prevents reaction with electrophilic reactive groups. For functional assays, 679 Compound 4/2 (PEG_4) is activated as described above.

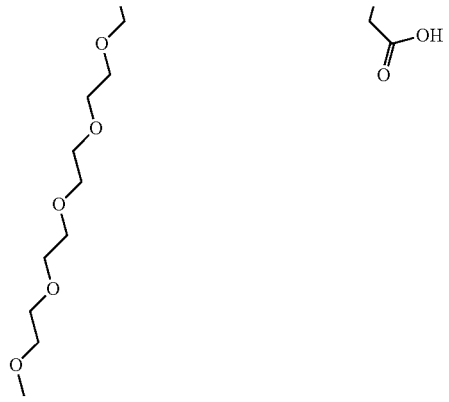
In one embodiment, the compound is 679 Compound 5/2 (PEG_4)



One non-limiting example of 679 Compound 5/2 (PEG_4) (2-((1E,3E,5E)-5-(3-(5-carboxypentyl)-1-methyl-6,8-disulfonato-1-(2,5,8,11-tetraoxatridecan-13-yl)-1H-benzo[e]indol-2(3H)-ylidene)penta-1,3-dienyl)-3-(2,5,8,11,14-pentaoxahexadecan-16-yl)-1-methyl-1-(3-sulfonatopropyl)-1H-benzo[e]indolium-6,8-disulfonate) contains a (poly)ethylene glycol on the indole N of the left heterocycle and a PEG_4 group on the indole C. The methyl group on the ethylene glycol prevents the terminal —OH from oxidation. Oxidation is known to occur, over time, on an unprotected PEG terminus. Adding a methyl ether provides this protection, and prevents reaction with electrophilic reactive groups. For functional assays, 679 Compound 5/2 (PEG_4) is activated as described above.

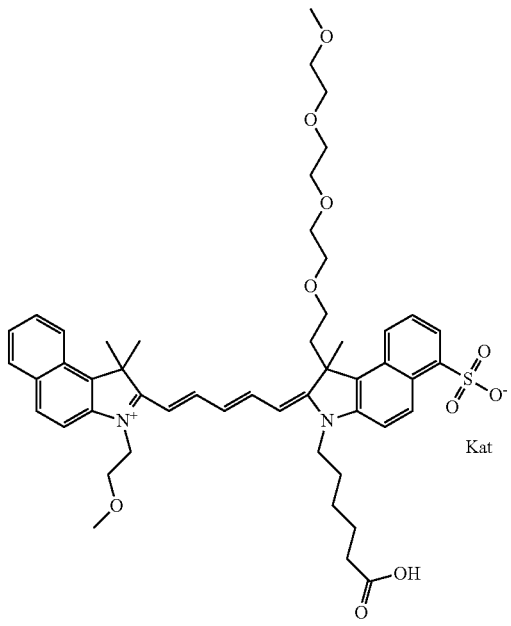
In one embodiment, the compound is 679 Compound 6/2 (PEG_4)



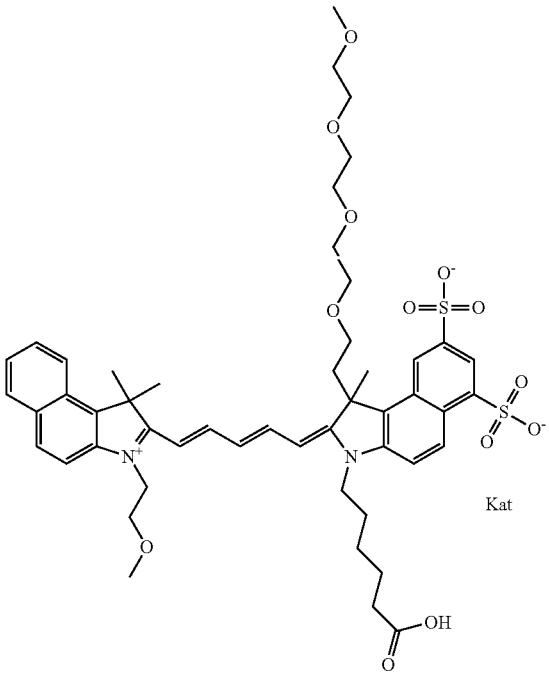


One non-limiting example of 679 Compound 6/2 (PEG_4) (2-((1E,3E,5E)-5-(3-(5-carboxypentyl)-1-methyl-6,8-disulfonato-1-(2,5,8,11-tetraoxatridecan-13-yl)-1H-benzo[e]indol-2(3H)-ylidene)penta-1,3-dienyl)-1-methyl-3-(2,5,8,11,14,17-hexaoxanonadecan-19-yl)-1-(3-sulfonatopropyl)-1H-benzo[e]indolium-6,8-disulfonate) contains a (poly)ethylene glycol on the indole N of the left heterocycle and a PEG_4 group on the indole C. The methyl group on the ethylene glycol prevents the terminal —OH from oxidation. Oxidation is known to occur, over time, on an unprotected PEG terminus. Adding a methyl ether provides this protection, and prevents reaction with electrophilic reactive groups. For functional assays, 649 Compound 6/2 (PEG_4) is activated as described above.

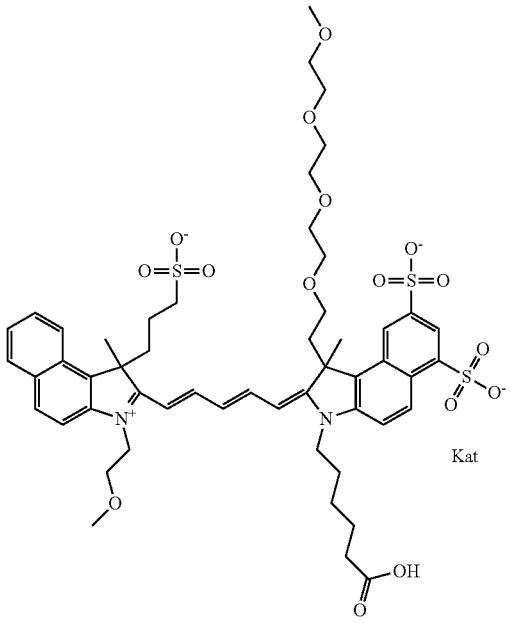
In embodiments, the degree and/or location of sulfonation is varied to, e.g., vary the compound's degree of hydrophilicity or hydrophobicity. One non-limiting example is a monosulfonate form of 679 Compound 1/2 (PEG_4), shown below:



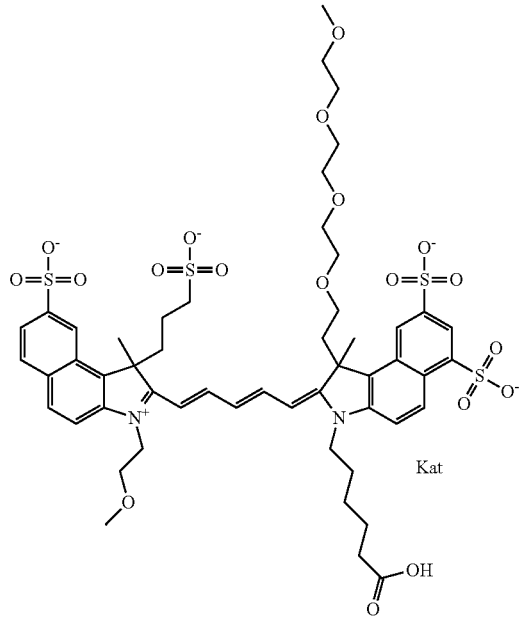
One non-limiting example is a disulfonate form of 679 Compound 1/2 (PEG_4), shown below:



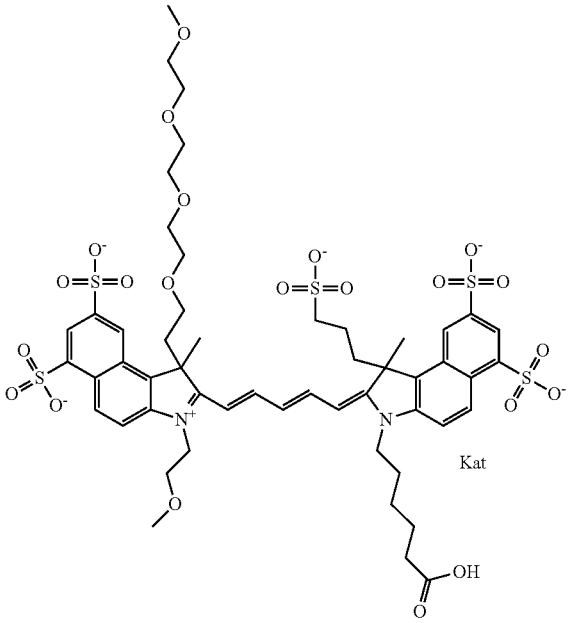
One non-limiting example is a trisulfonate form of 679 Compound 1/2 (PEG_4), shown below:



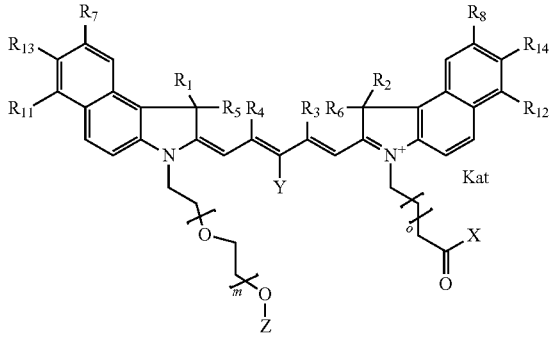
One non-limiting example is a tetrasulfonate form of 679 Compound 1/2 (PEG_4), shown below:



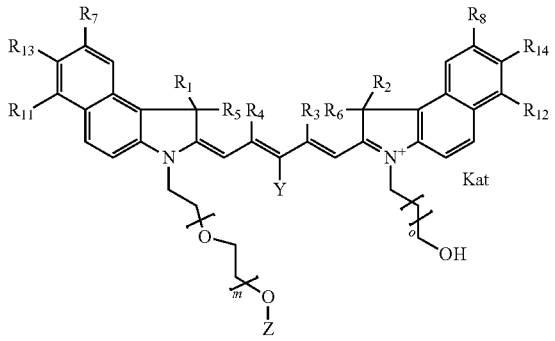
One non-limiting example is a pentasulfonate form of 679 Compound 1/2 (PEG_4), shown below:



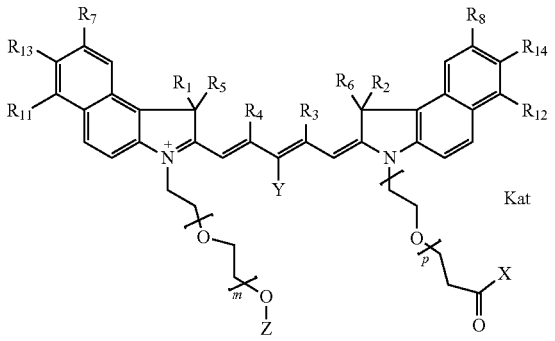
In embodiments, the compound contains one or more substitutions of the polymethine linker. In one embodiment, the compound has general formula Va



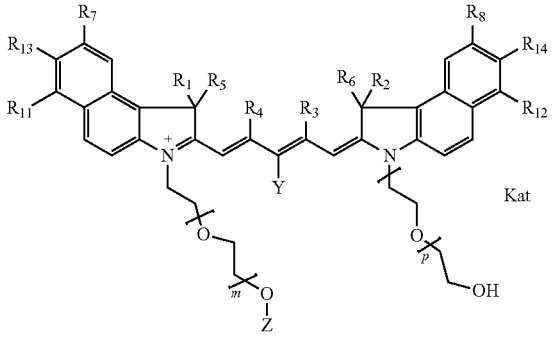
general formula Vb



general formula Vc



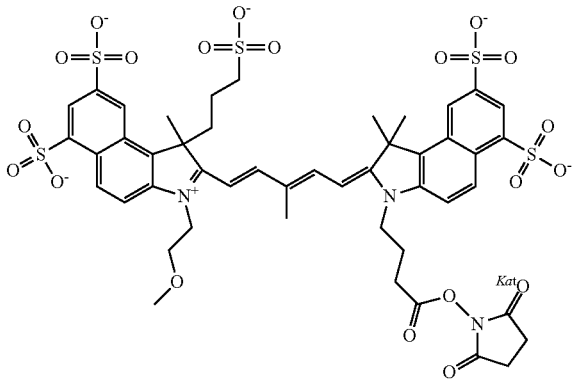
general formula Vd



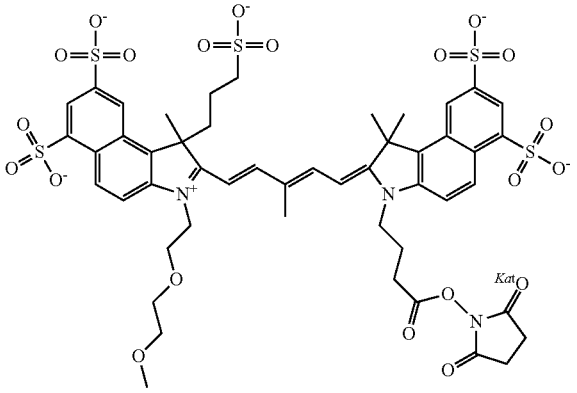
where each of R^1, R^2, R^5, and R^6 is the same or different and is independently selected from the group consisting of an aliphatic, heteroaliphatic, sulfoalkyl group, heteroaliphatic with terminal SO_3, a PEG group P—Z where P is selected from an ethylene glycol group, a diethylene glycol group, and a polyethylene glycol group, where the polyethylene glycol group is $(CH_2CH_2O)_s$, where s is an integer from 3-6 inclusive, a sulfonamide group -L-SO_2NH—P—Z, and a carboxamide group -L-CONH—P—Z, and Z is selected from H, a CH_3 group, an alkyl group, a heteroalkyl group, or —CO—NHS; each of R^7, R^8, R^{11}, R^{12}, R^{13}, and R^{14} is the same or different and is independently selected from either H, SO_3, a PEG group P—Z where P is selected from an ethylene glycol group, a diethylene glycol group, and a polyethylene glycol group, where the polyethylene glycol group is $(CH_2CH_2O)_s$, where s is an integer from 3-6 inclusive, a sulfonamide group —SO_2NH—P—Z, or a carboxamide group —CONH—P—Z, and Z is selected from H, a CH_3 group, an alkyl group, a heteroalkyl group, or —CO—NHS; X is selected from the group consisting of —OH, —SH, —NH_2, —NH—NH_2, —F, —Cl, —Br, I, —NHS hydroxysuccinimidyl/sulfosuccinimidyl), —O-TFP (2,3,5,6-tetrafluorophenoxy), —O-STP (4-sulfo-2,3,5,6-tetrafluorophenoxy), —O-benzotriazole, -benzotriazole, —NR-L-OH, —NR-L-O-phosphoramidite, —NR-L-SH, —NR-L-NH_2, —NR-L-NH—NH_2, —NR-L-CO_2H, —NR-L-CO—NHS, —NR-L-CO-STP, —NR-L-CO-TFP, —NR-L-CO-benzotriazole, —NR-L-CHO, —NR-L-maleimide, —NR-L-NH—CO—CH2-I, imidazole, azide, —NR-L-O—NH2, and —NR-L-O—CO—NHS, where R is —H or an aliphatic or heteroaliphatic group, and L is selected from the group consisting of a divalent linear (—$(CH_2)_t$—, t=0 to 15), crossed, or cyclic alkyl group optionally substituted by at least one oxygen atom and/or sulfur atom; Kat is a number of Na^+, K^+, Ca^{2+}, ammonia, or other cation(s) needed to compensate the negative charge brought by the cyanine; m is an integer from 0 to 5 inclusive; o is an integer from 0 to 12 inclusive; p is an integer from 1 to 6 inclusive; each of R3 and R4 is the same or different and is independently hydrogen, an aliphatic group, a heteroaliphatic group, a PEG group P—Z where P is selected from an ethylene glycol group, a diethylene glycol group, and a polyethylene glycol group, where the polyethylene glycol group is $(CH_2CH_2O)_s$, where s is an integer from 3-6 inclusive, and Z is selected from H, CH_3, a CH_3 group, an alkyl group, or a heteroalkyl group; or R3 and R4 together form a cyclic structure where R3 and R4 are joined using a divalent structural element selected from the group consisting of —$(CH_2)_q$—, —$(CH_2)_q$O$(CH_2)_{q'}$—, —$(CH_2)_q$S$(CH_2)_{q'}$—, —$(CH_2)_q$CH=CH—, and —OCH=CH— where each of q and q' is the same or different and is a integer from 2 to 6 inclusive; and Y is selected from the group consisting of hydrogen, alkyl, sulfoalkyl, fluorine, chlorine, bromine, a substituted or unsubstituted aryl-, phenoxy-, phenylmercapto function, and a PEG group P—Z where P is selected from an ethylene glycol group, a diethylene glycol group, and a polyethylene glycol group, where the polyethylene glycol group is $(CH_2CH_2O)_s$, where s is an integer from 3-6 inclusive, and Z is selected from H, CH_3, a CH_3 group, an alkyl group, a heteroalkyl group, or —CO—NHS.

In one embodiment, the compound of general formula V wherein each of R3 and R4 is the same or different and is independently hydrogen, an aliphatic group, or a heteroaliphatic group, or R3 and R4 together form acyclic structure where R3 and R4 are directly joined or joined using a divalent structural element selected from the group consisting of —$(CH_2)_q$— and CH=CH, where q is an integer from 1 to 2 inclusive, to result in a 3-, 4-, or 5-membered ring.

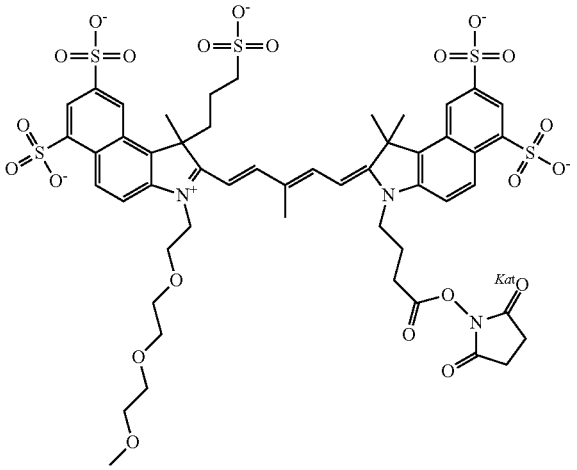
One non-limiting example is a substituted polymethine form of 679 Compound 1, shown below:



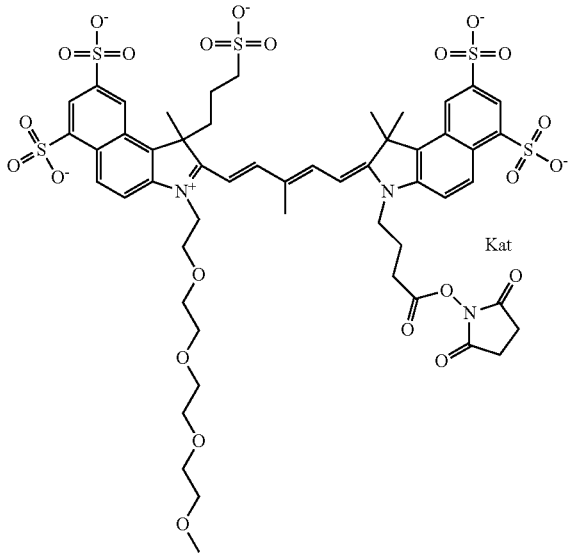
One non-limiting example is a substituted polymethine form of 679 Compound 2, shown below:



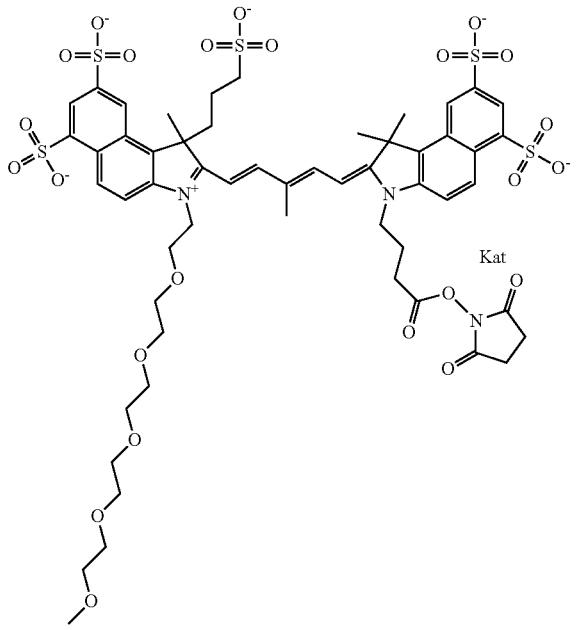
One non-limiting example is a substituted polymethine form of 679 Compound 3, shown below:



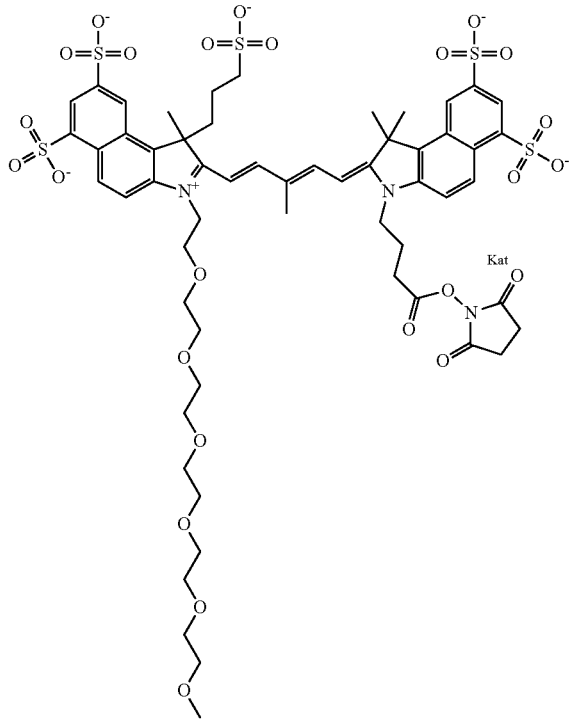
One non-limiting example is a substituted polymethine form of 679 Compound 4, shown below:



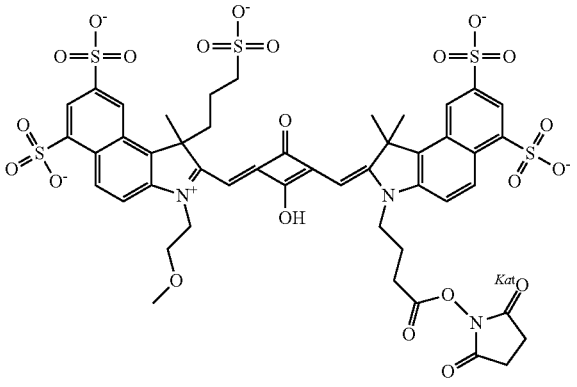
One non-limiting example is a substituted polymethine form of 679 Compound 5, shown below:



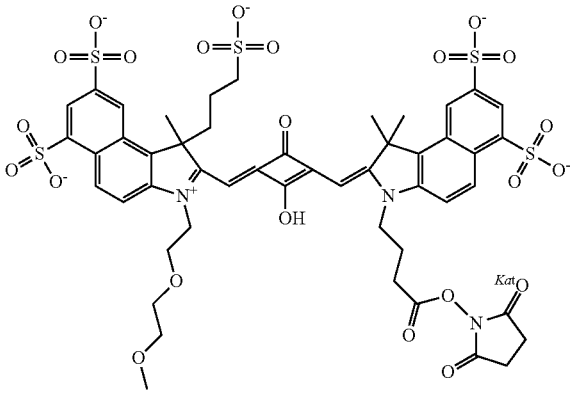
One non-limiting example is a substituted polymethine form of 679 Compound 6, shown below:



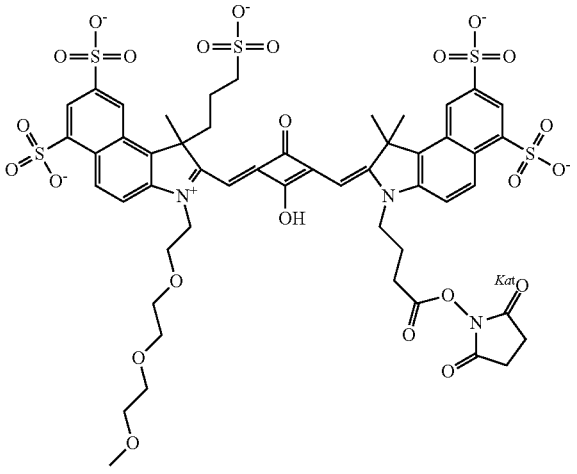
One non-limiting example is a substituted polymethine form of 679 Compound 1, shown below:



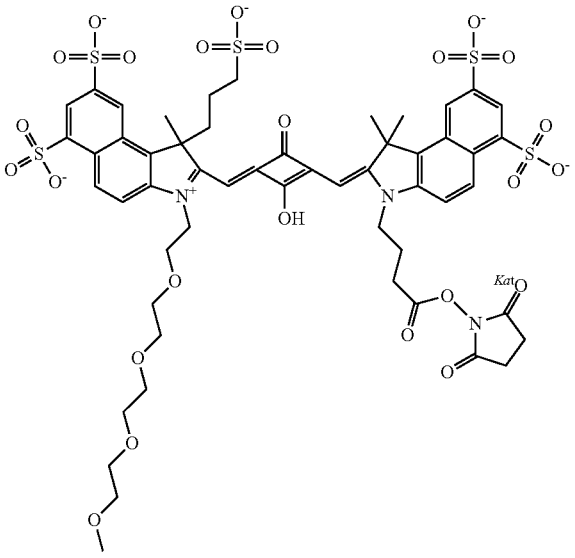
One non-limiting example is a substituted polymethine form of 679 Compound 2, shown below:



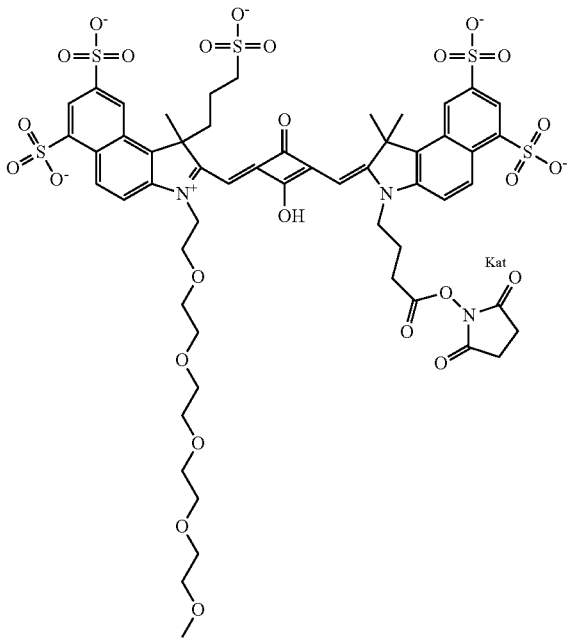
One non-limiting example is a substituted polymethine form of 679 Compound 3, shown below:



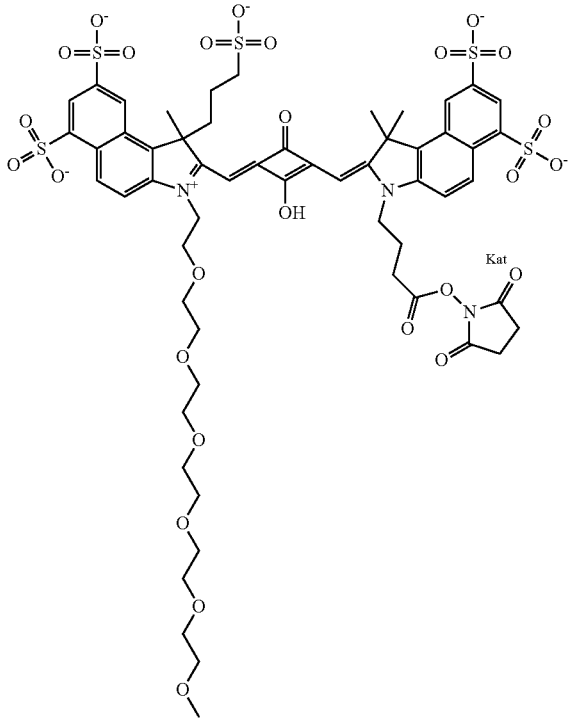
One non-limiting example is a substituted polymethine form of 679 Compound 4, shown below:



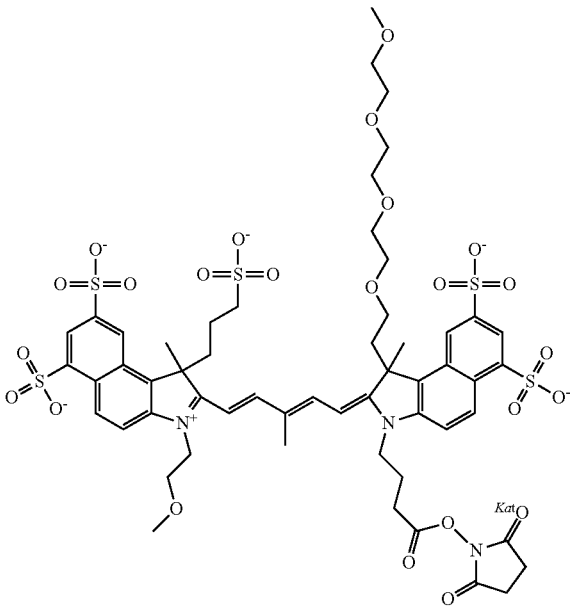
One non-limiting example is a substituted polymethine form of 679 Compound 5, shown below:



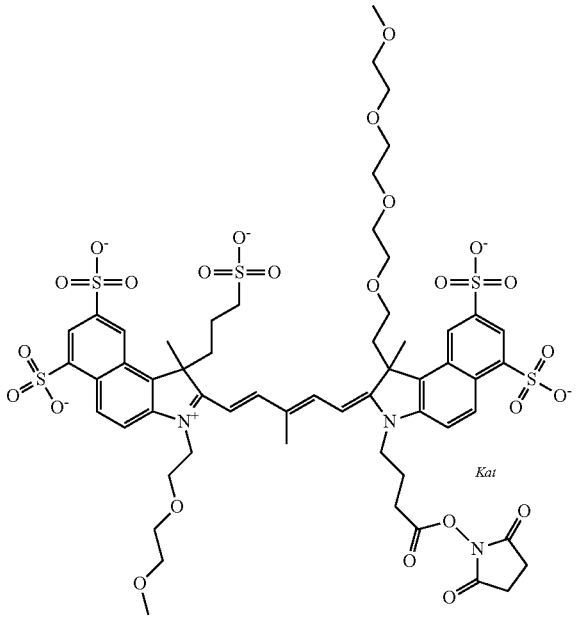
One non-limiting example is a substituted polymethine form of 679 Compound 6, shown below:



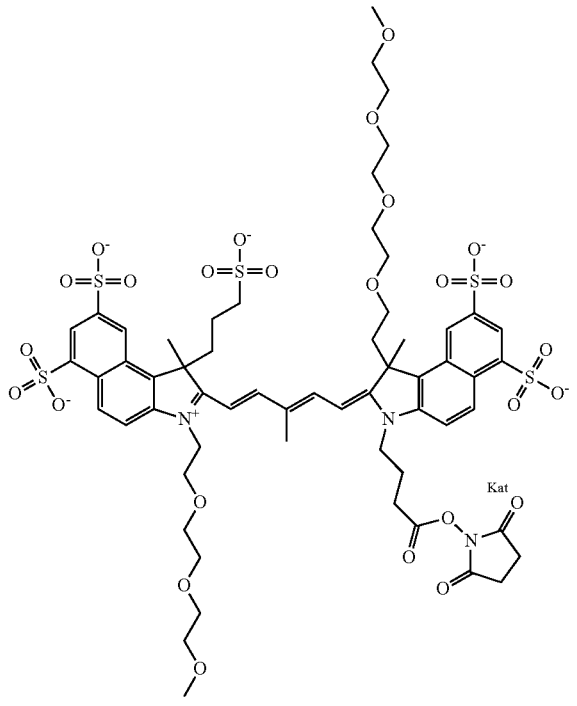
One non-limiting example is a substituted polymethine form of 679 Compound 1/2 (PEG_4), shown below:



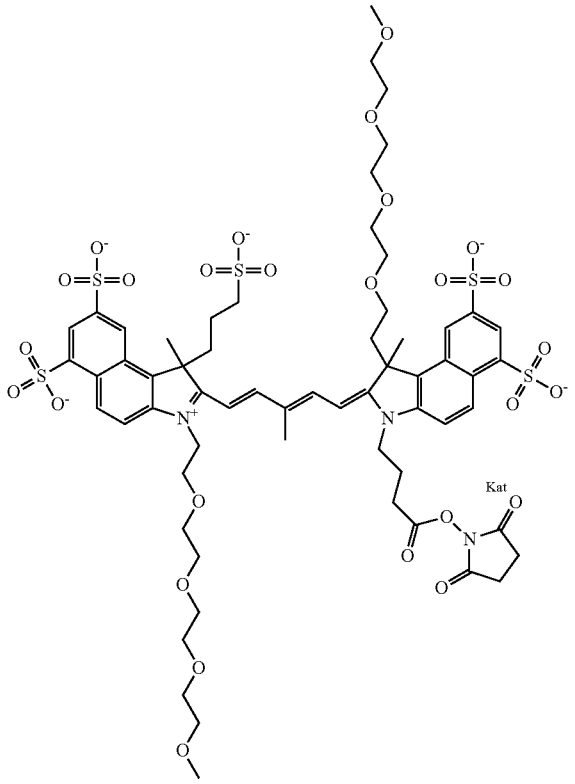
One non-limiting example is a substituted polymethine form of 679 Compound 2/2 (PEG_4), shown below:



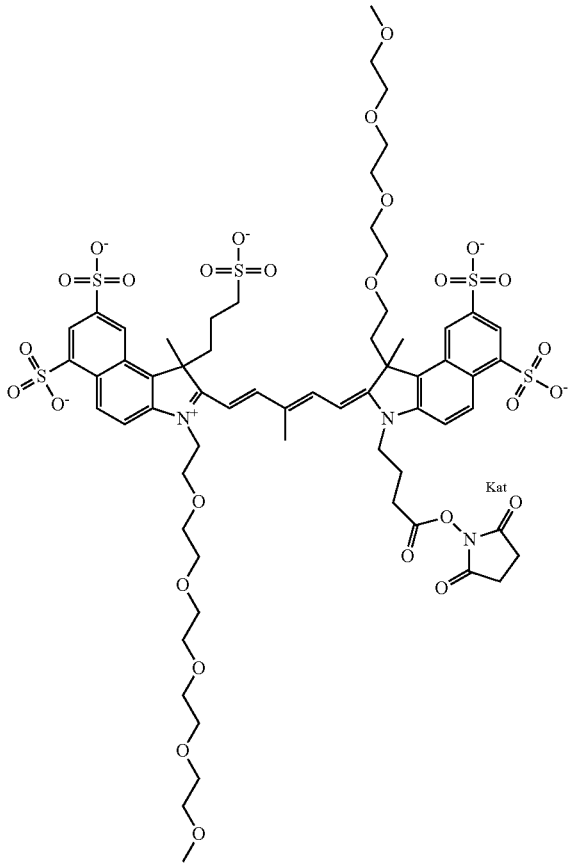
One non-limiting example is a substituted polymethine form of 679 Compound 3/2 (PEG_4), shown below:



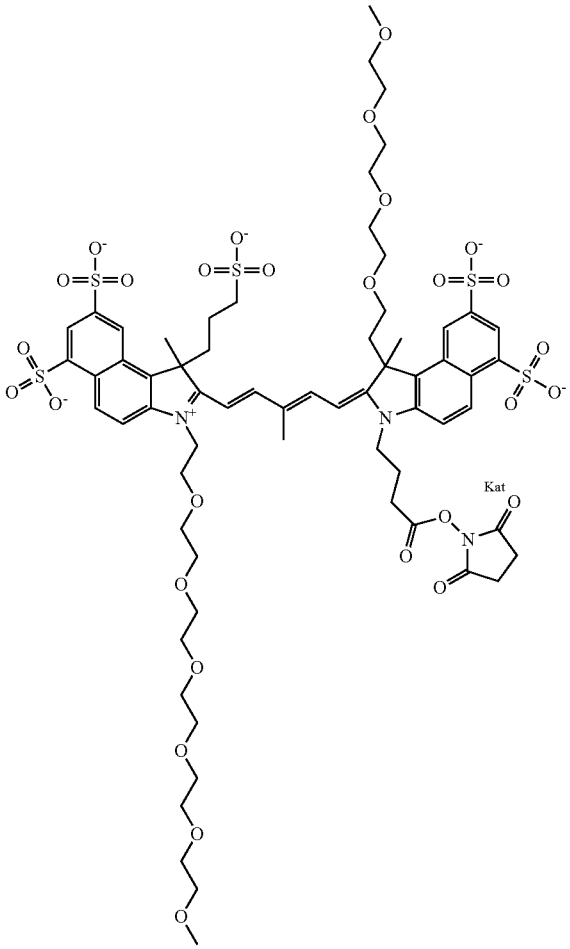
One non-limiting example is a substituted polymethine form of 679 Compound 4/2 (PEG_4), shown below:



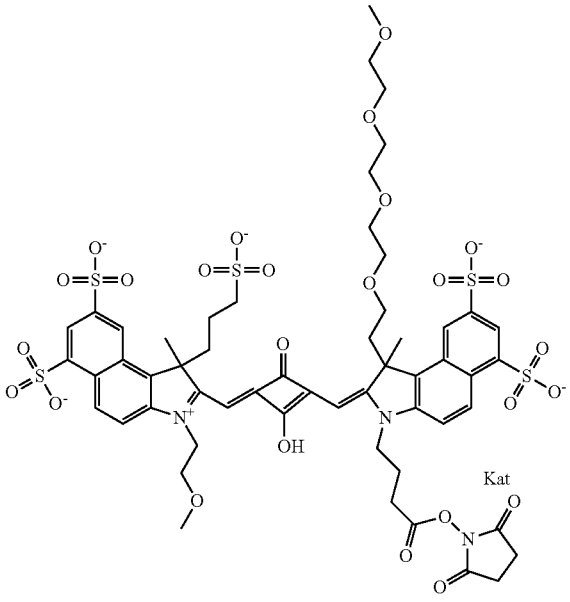
One non-limiting example is a substituted polymethine form of 679 Compound 5/2 (PEG_4), shown below:



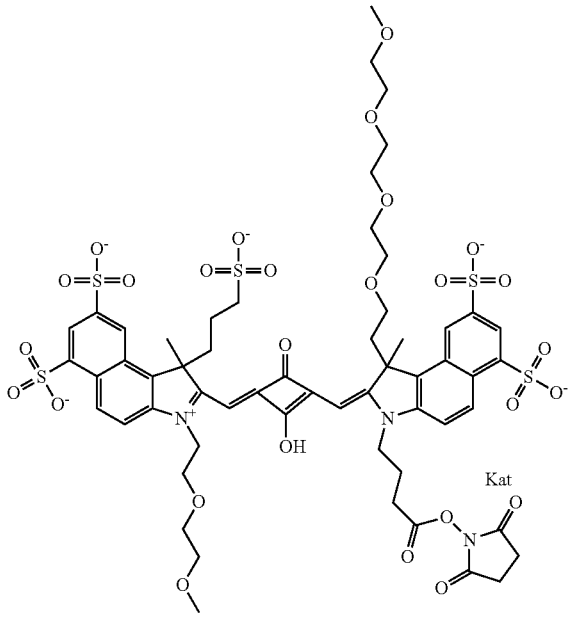
One non-limiting example is a substituted polymethine form of 679 Compound 6/2 (PEG_4), shown below:



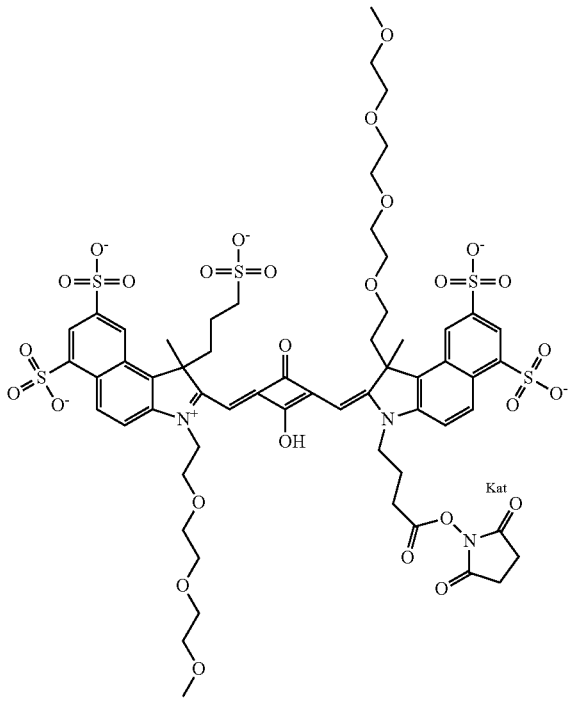
One non-limiting example is a substituted polymethine form of 679 Compound 1/2 (PEG_4), shown below:



One non-limiting example is a substituted polymethine form of 679 Compound 2/2 (PEG_4), shown below:

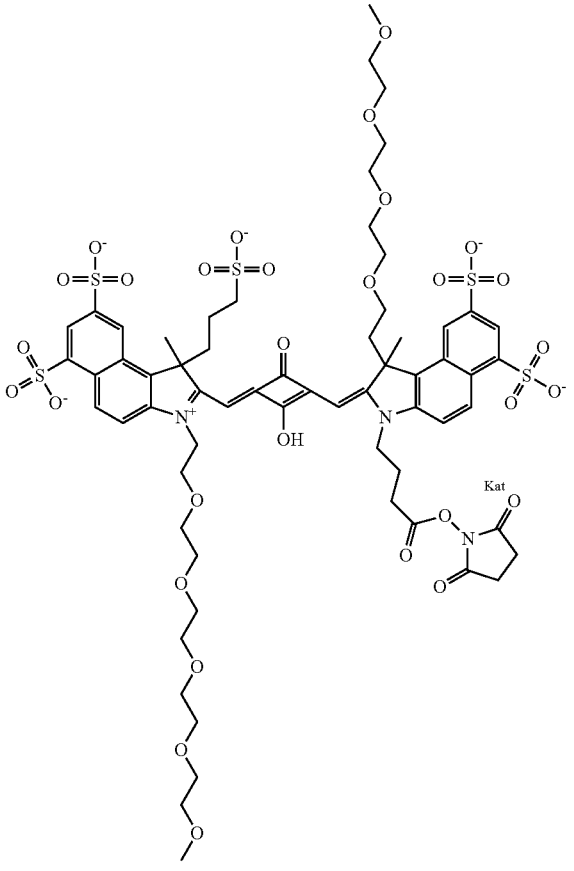


One non-limiting example is a substituted polymethine form of 679 Compound 3/2 (PEG_4), shown below:

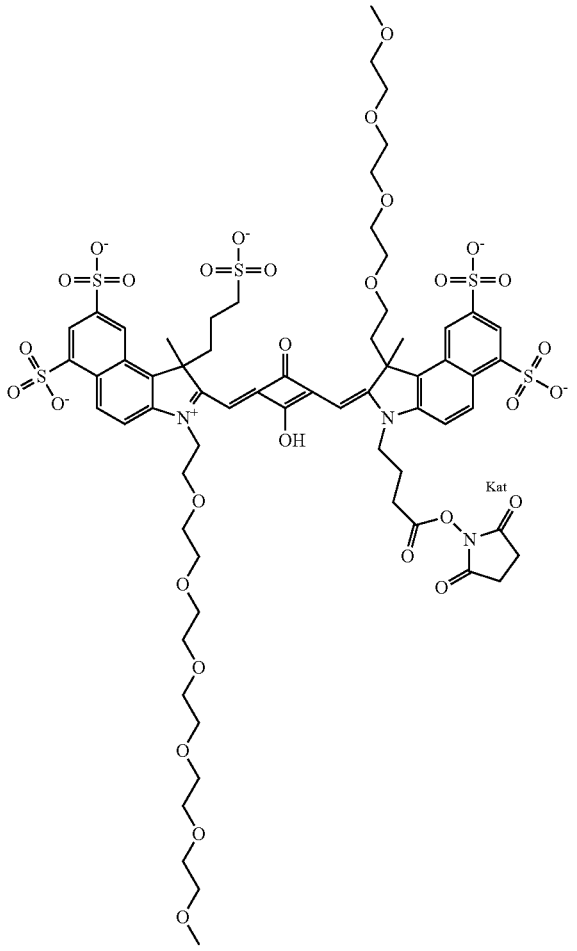


One non-limiting example is a substituted polymethine form of 679 Compound 4/2 (PEG_4), shown below:

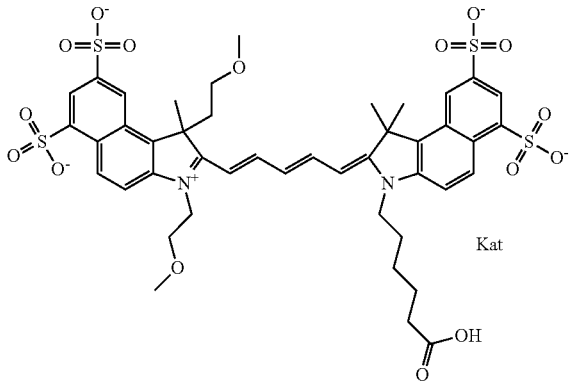
One non-limiting example is a substituted polymethine form of 679 Compound 5/2 (PEG_4), shown below:



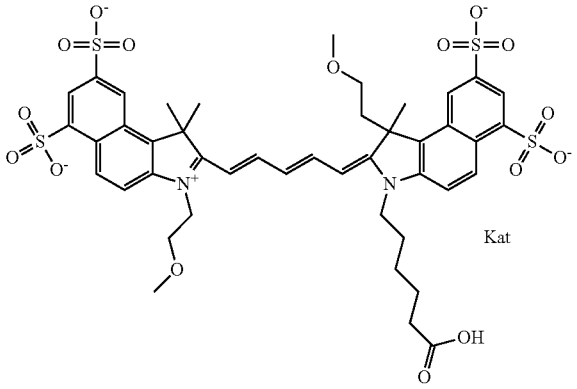
One non-limiting example is a substituted polymethine form of 679 Compound 6/2 (PEG_4), shown below:



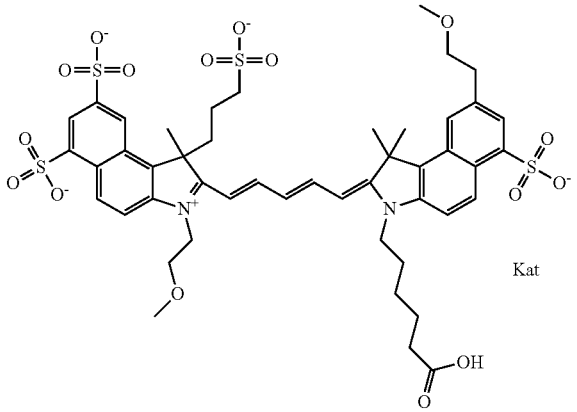
In various embodiments, an ethylene glycol group, diethylene glycol group, and/or a polyethylene glycol group, which will collectively be referred to as a PEG group, unless specifically defined, may be present at position(s) in addition to such groups being present on the N atom(s) of the indole structure. One non-limiting example of an additionally PEG-substituted compound is a 679 Compound 1/2 according to general formula II where R1 is an ethylene glycol group terminating with a methyl group, shown below:



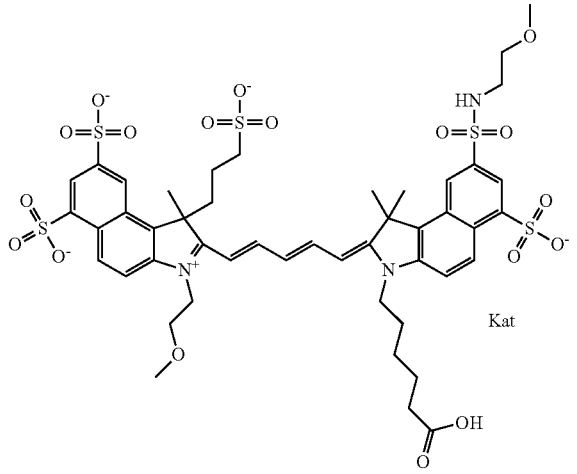
One non-limiting example of an additionally PEG-substituted compound is a 679 Compound 1/2 according to general formula II where R2 is an ethylene glycol group terminating with a methyl group, shown below:



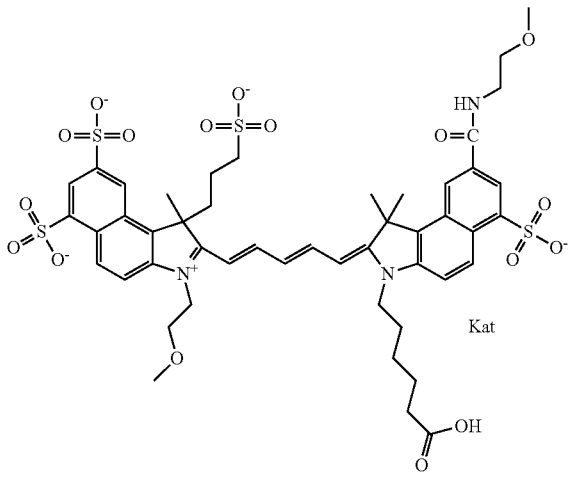
One non-limiting example of an additionally PEG-substituted compound is a 679 Compound 1/2 according to general formula II where R8 is an ethylene glycol group terminating with a methyl group, shown below:



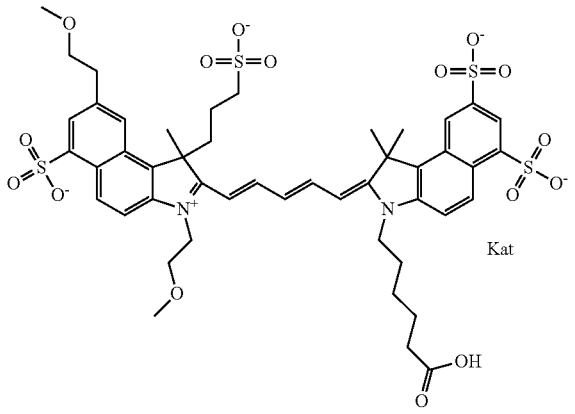
One non-limiting example of an additionally PEG-substituted compound is a 679 Compound 1/2 according to general formula II where R8 is a sulfonamide group with an ethylene glycol group (PEG_1) terminating with a methyl group, shown below:



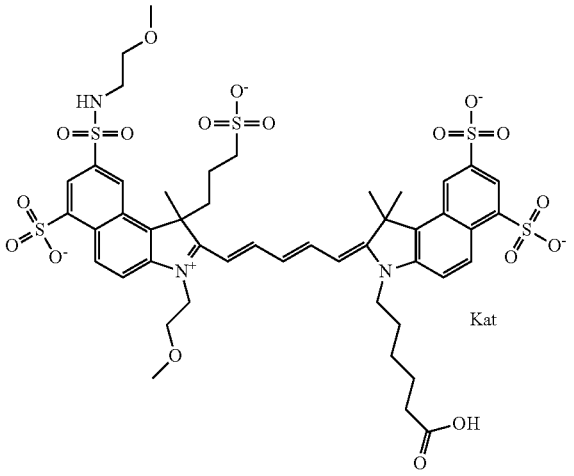
One non-limiting example of an additionally PEG-substituted compound is a 679 Compound 1/2 according to general formula II where R8 is a carboxamide group with an ethylene glycol group (PEG_1) terminating with a methyl group, shown below:



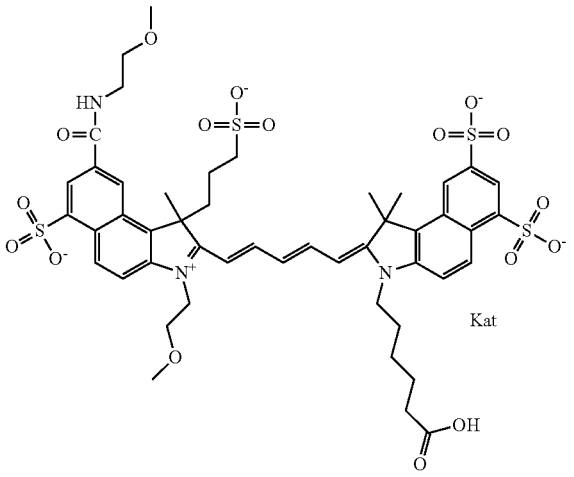
One non-limiting example of an additionally PEG-substituted compound is a 679 Compound 1/2 according to general formula II where R7 is an ethylene glycol group terminating with a methyl group, shown below:



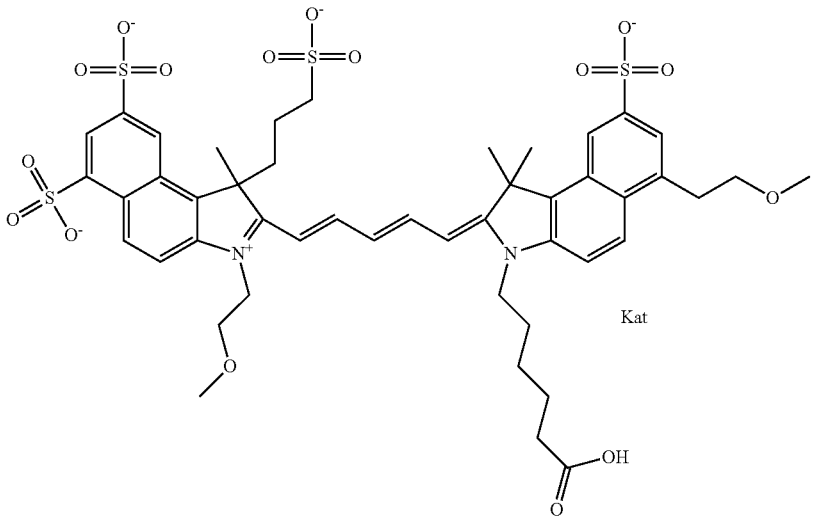
One non-limiting example of an additionally PEG-substituted compound is a 679 Compound 1/2 according to general formula II where R7 is a sulfonamide group with an ethylene glycol group (PEG_1) terminating with a methyl group, shown below:



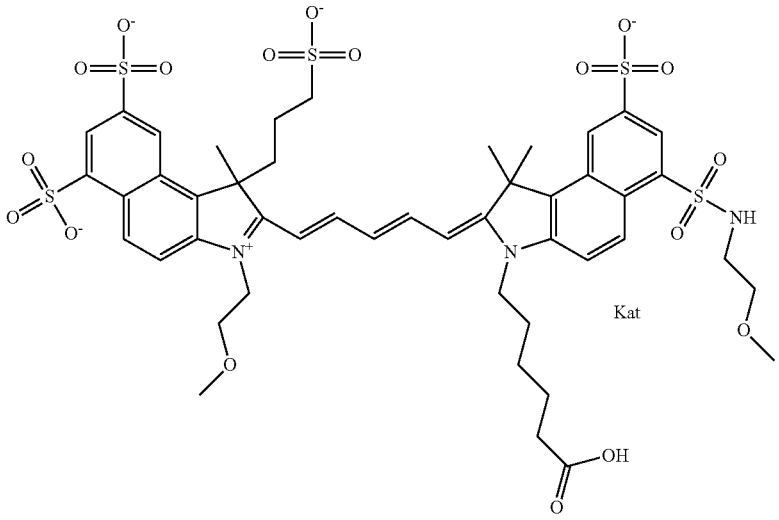
One non-limiting example of an additionally PEG-substituted compound is a 679 Compound 1/2 according to general formula II where R7 is a carboxamide group with an ethylene glycol group (PEG_1) terminating with a methyl group, shown below:



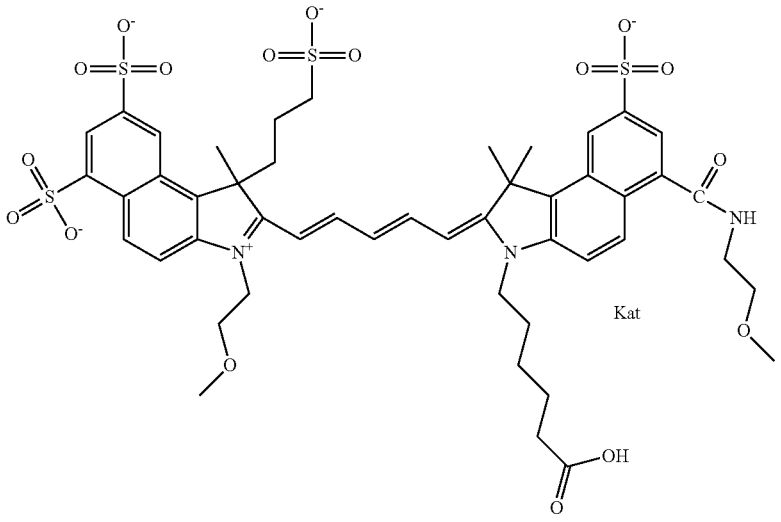
One non-limiting example of an additionally PEG-substituted compound is a 679 Compound 1/2 according to general formula II where R12 is an ethylene glycol group terminating with a methyl group, shown below:



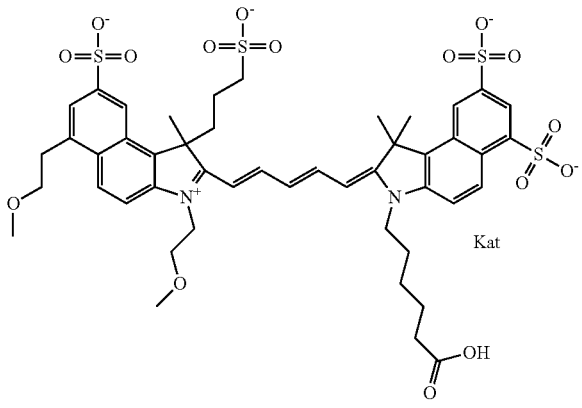
One non-limiting example of an additionally PEG-substituted compound is a 679 Compound 1/2 according to general formula II where R12 is a sulfonamide group with an ethylene glycol group (PEG_1) terminating with a methyl group, shown below:



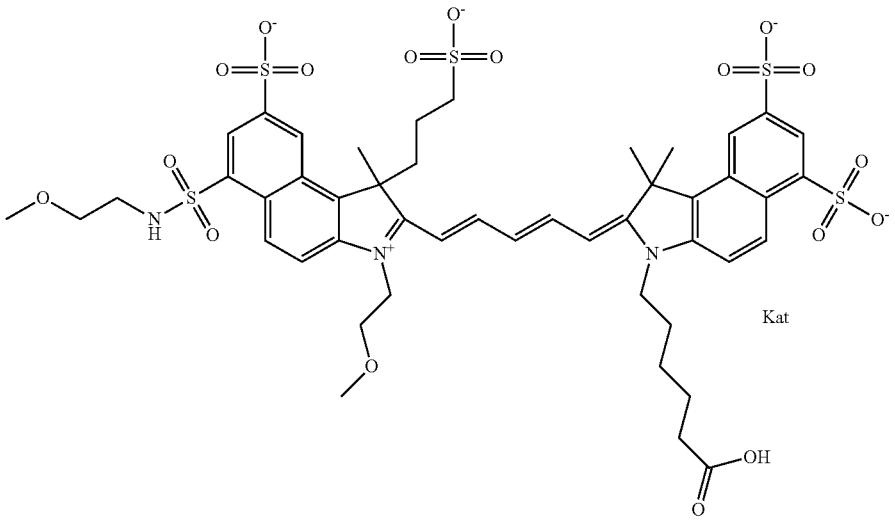
One non-limiting example of an additionally PEG-substituted compound is a 679 Compound 1/2 according to general formula II where R12 is a carboxamide group with an ethylene glycol group (PEG_1) terminating with a methyl group, shown below:



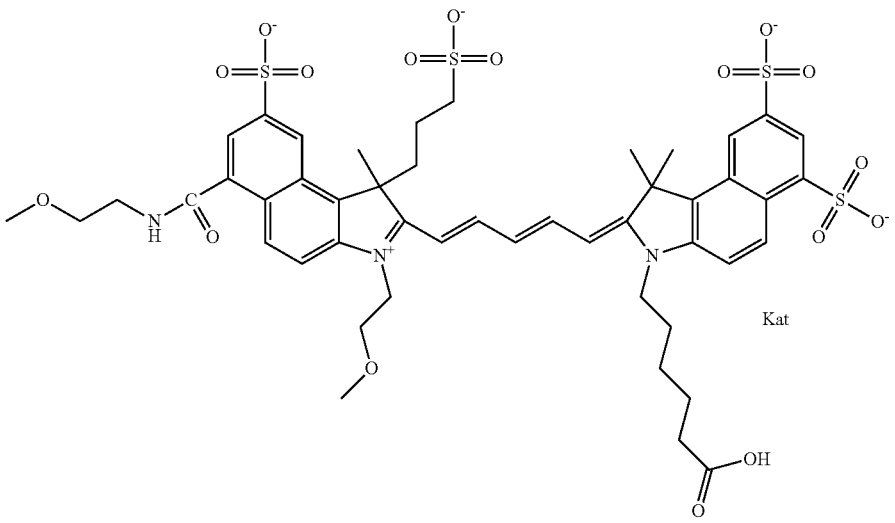
One non-limiting example of an additionally PEG-substituted compound is a 679 Compound 1/2 according to general formula II where R11 is an ethylene glycol group terminating with a methyl group, shown below:



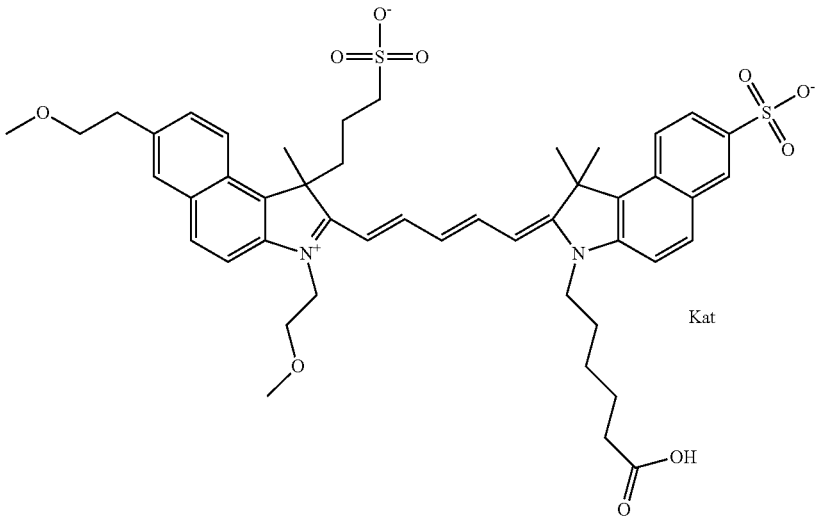
One non-limiting example of an additionally PEG-substituted compound is a 679 Compound 1/2 according to general formula II where R11 is a sulfonamide group with an ethylene glycol group (PEG_1) terminating with a methyl group, shown below:



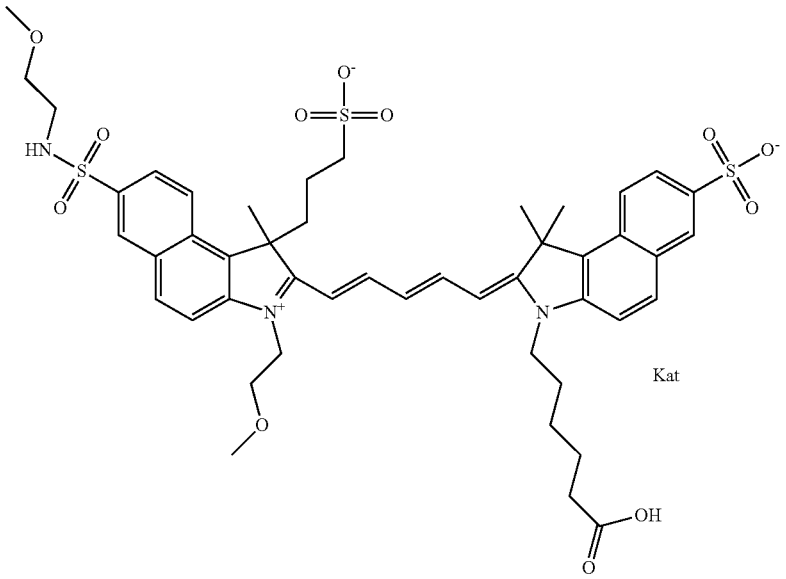
One non-limiting example of an additionally PEG-substituted compound is a 679 Compound 1/2 according to general formula II where R11 is a carboxamide group with an ethylene glycol group (PEG_1) terminating with a methyl group, shown below:



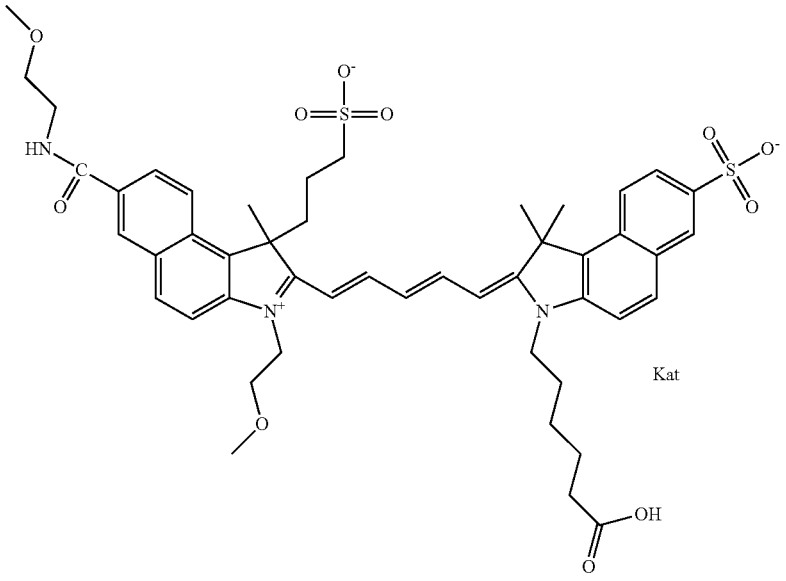
One non-limiting example of an additionally PEG-substituted compound is a 679 Compound 1/2 according to general formula II where R13 is an ethylene glycol group terminating with a methyl group, shown below:



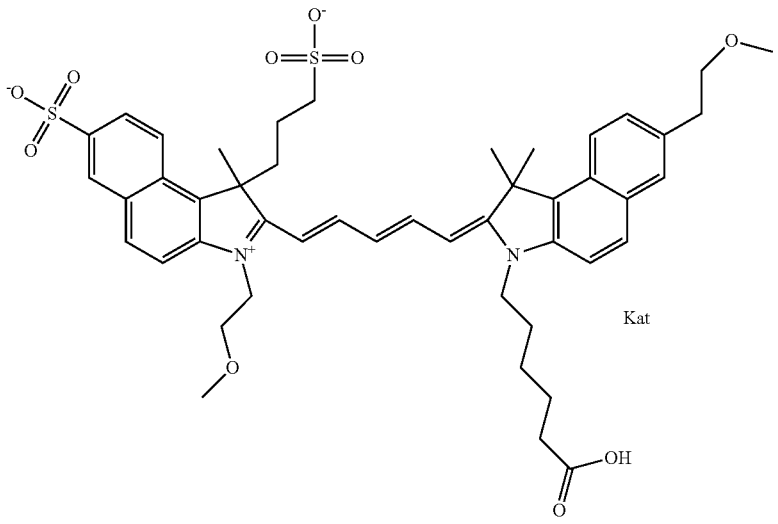
One non-limiting example of an additionally PEG-substituted compound is a 679 Compound 1/2 according to general formula II where R13 is a sulfonamide group with an ethylene glycol group (PEG_1) terminating with a methyl group, shown below:



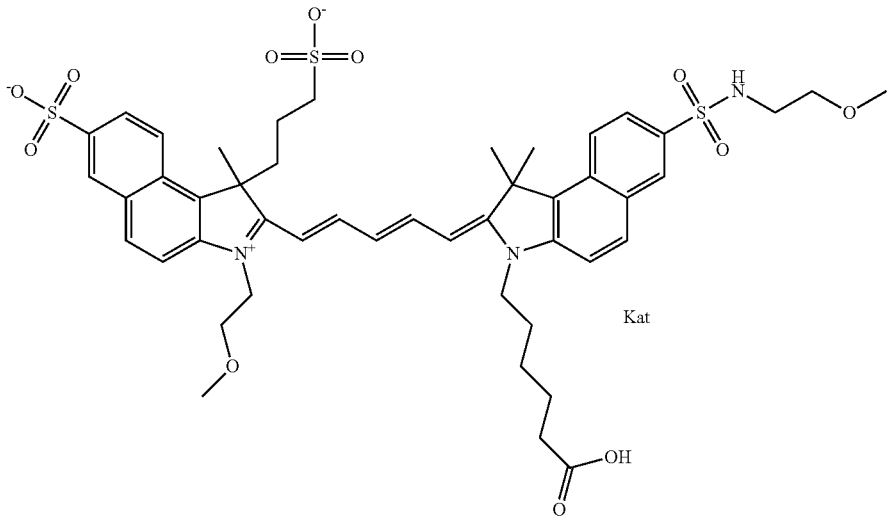
One non-limiting example of an additionally PEG-substituted compound is a 679 Compound 1/2 according to general formula II where R13 is a carboxamide group with an ethylene glycol group (PEG_1) terminating with a methyl group, shown below:



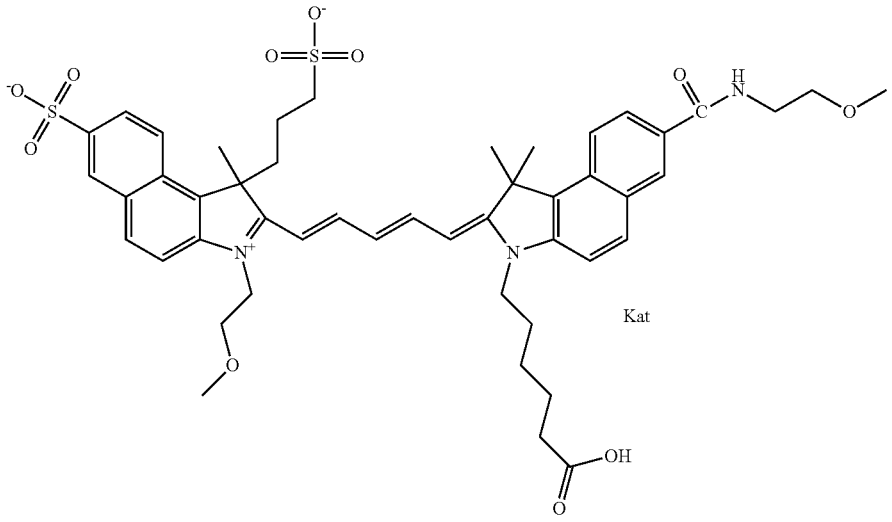
One non-limiting example of an additionally PEG-substituted compound is a 679 Compound 1/2 according to general formula II where R14 is an ethylene glycol group terminating with a methyl group, shown below:



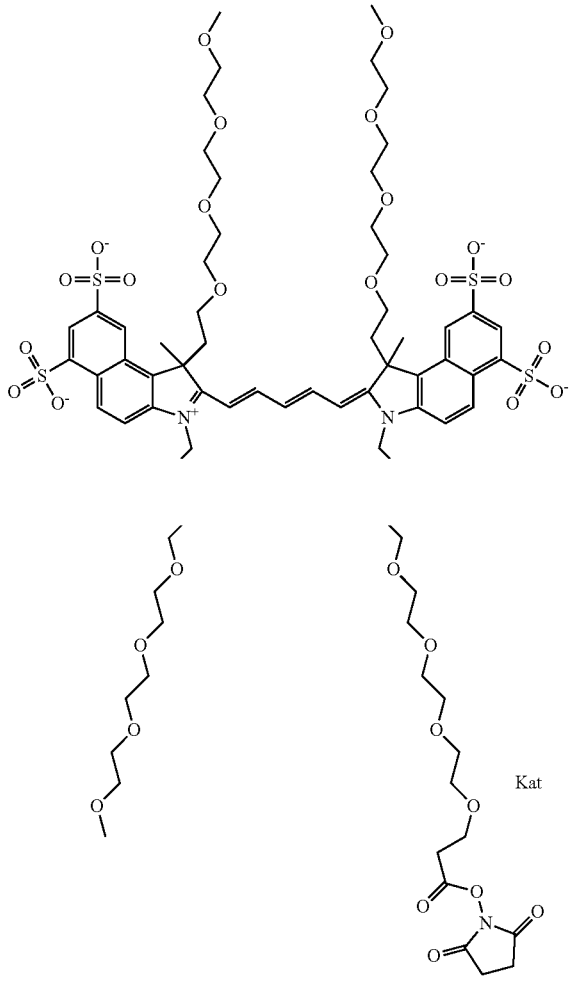
One non-limiting example of an additionally PEG-substituted compound is a 679 Compound 1/2 according to general formula II where R13 is a sulfonamide group with an ethylene glycol group (PEG_1) terminating with a methyl group, shown below:



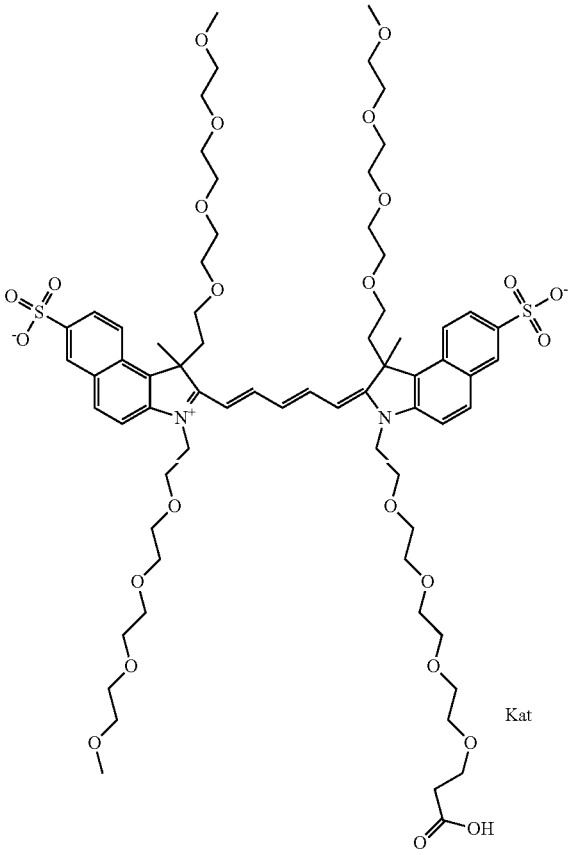
One non-limiting example of an additionally PEG-substituted compound is a 679 Compound 1/2 according to general formula II where R13 is a carboxamide group with an ethylene glycol group (PEG_1) terminating with a methyl group, shown below:



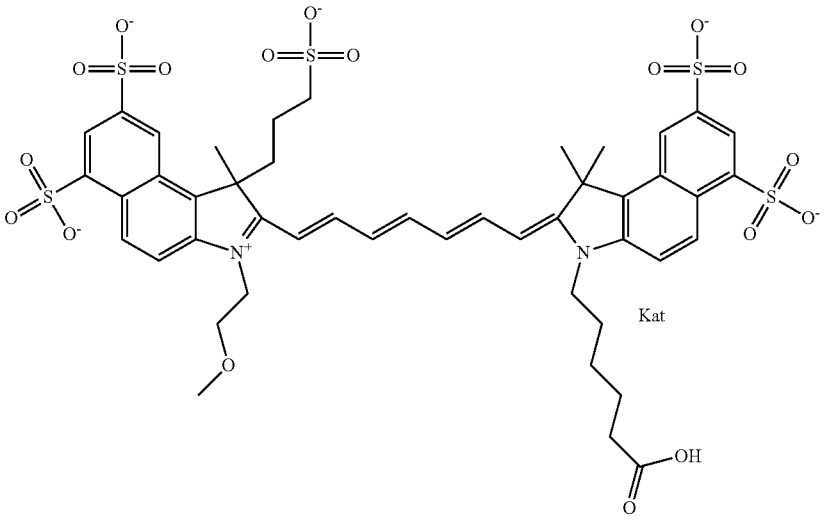
One non-limiting example of an additionally PEG-substituted compound is a 679 Compound 4/4 (V08-15173) according to general formula III where each of R1 and R2 is a polyethylene glycol (4) group terminating with a methyl group, p=4, X=NHS, and each of R7, R8, R11, and R12 are SO_3, shown below:



One non-limiting example of an additionally PEG-substituted compound is a 679 Compound 4/4 (V10-04152) according to general formula III where each of R1 and R2 is a polyethylene glycol (4) group terminating with a methyl group, p=4, X=OH, and each of R13 and R14 are SO_3, shown below:

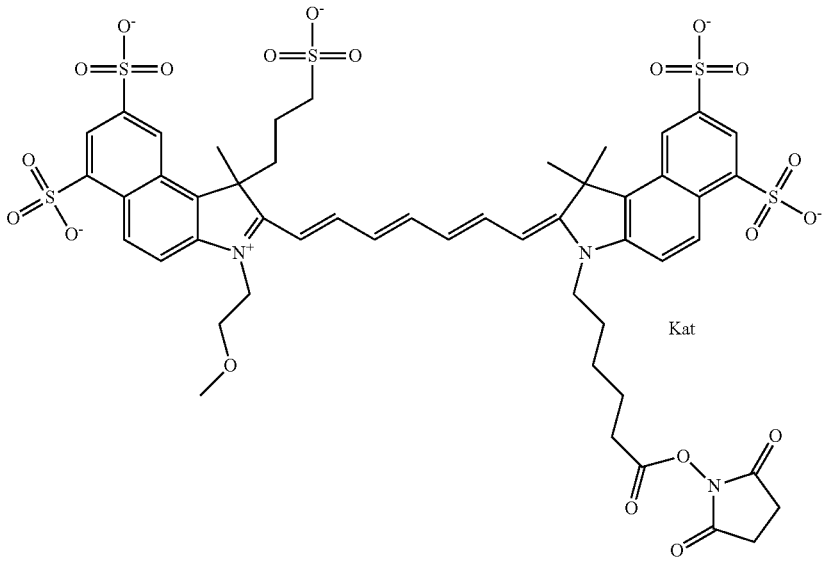


In one embodiment, the compound is 779 Compound 1

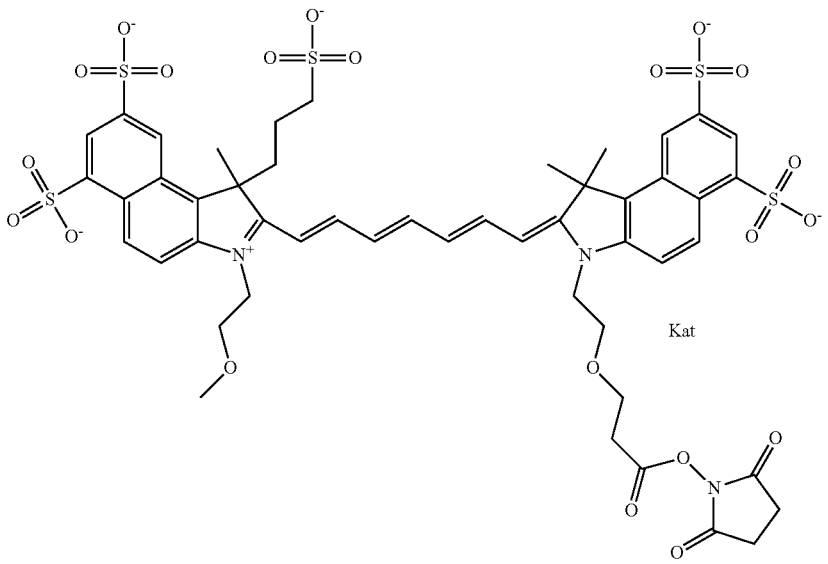


779 Compound 1 (6-((E)-2-(2E,4E,6E)-7-(3-(2-methoxyethyl)-1-methyl-6,8-disulfonato-1-(3-sulfonatopropyl)-1H-benzo[e]indol-3-ium-2-yl)hepta-2,4,6-trien-1-ylidene)-1,1-dimethyl-6,8-disulfonato-1H-benzo[e]indol-3(2H)-yl) hexanoate) contains an ethylene glycol on the indole N of the left heterocycle, i.e., a methylated ethylene glycol. The methyl group on the ethylene glycol prevents the terminal —OH from oxidation. Oxidation is known to occur, over time, on an unprotected PEG terminus. Adding a methyl ether provides this protection, and prevents reaction with electrophilic reactive groups.

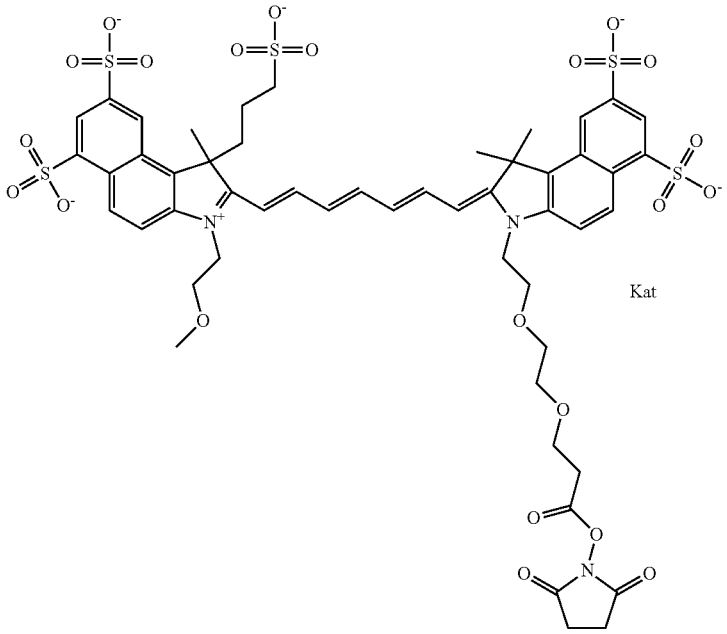
In embodiments, e.g., for functional assays, the inventive compounds are activated. Activation of the compound adds a chemical moiety such that the compound is in a form that can be conjugated to a biological moiety. Examples of chemical moieties for activation are described below with reference to activation of 779 Compound 1, but one skilled in the art appreciates that activation is not limited to these examples. One non-limiting example of an activated compound is the NHS-ester of 779 Compound 1, shown below:



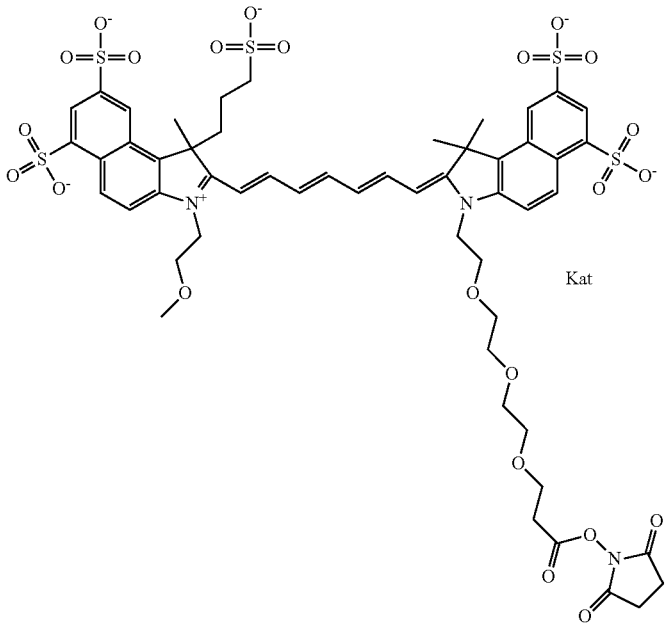
One non-limiting example of a NHS-ester of 779 Compound 1, according to general formula III, where m=1 and p=1, is shown below:



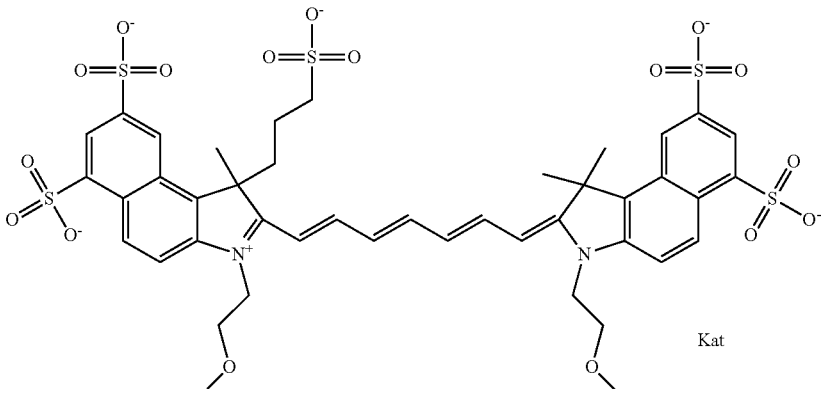
One non-limiting example of a NHS-ester of 779 Compound 1, according to general formula III, where m=1 and p=2, is shown below:

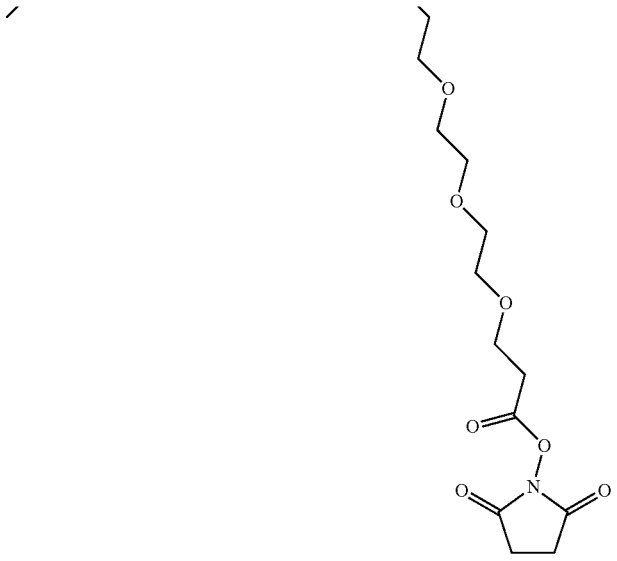


One non-limiting example of a NHS-ester of 779 Compound 1, according to general formula III, where m=1 and p=3, is shown below:

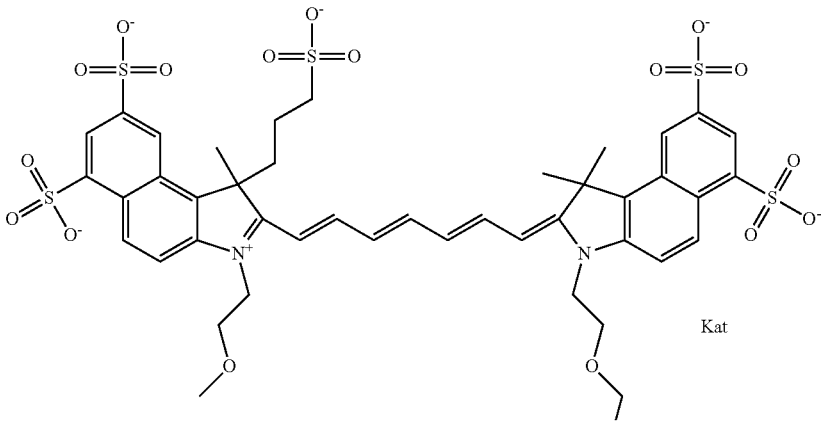


One non-limiting example of a NHS-ester of 779 Compound 1, according to general formula III, where m=1 and p=4, is shown below:





One non-limiting example of a NHS-ester of 779 Compound 1, according to general formula III, where m=1 and p=5, is shown below:



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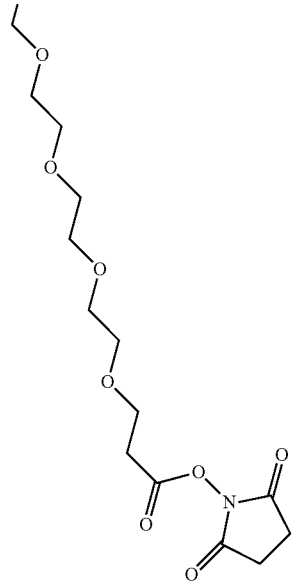
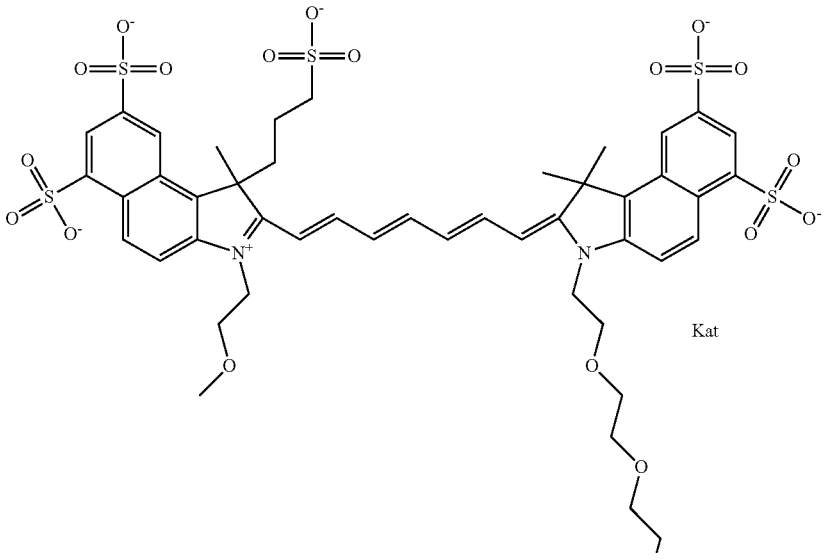


One non-limiting example of a NHS-ester of 779 Compound 1, according to general formula III, where m=1 and p=6, is shown below:



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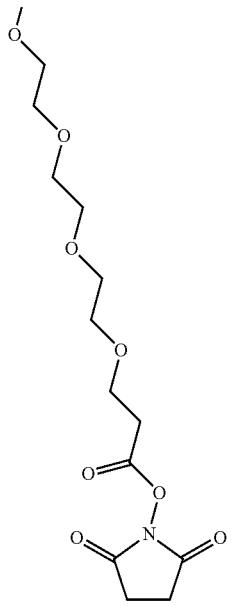
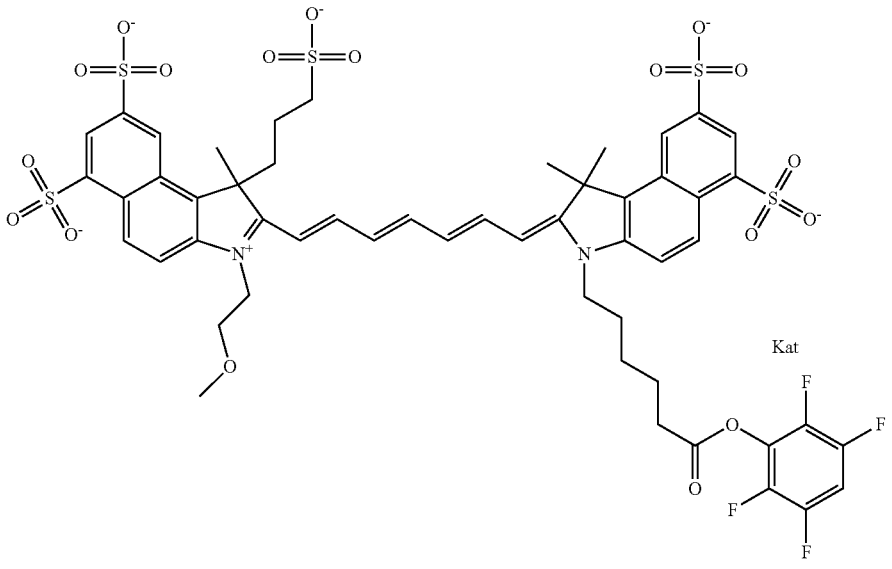
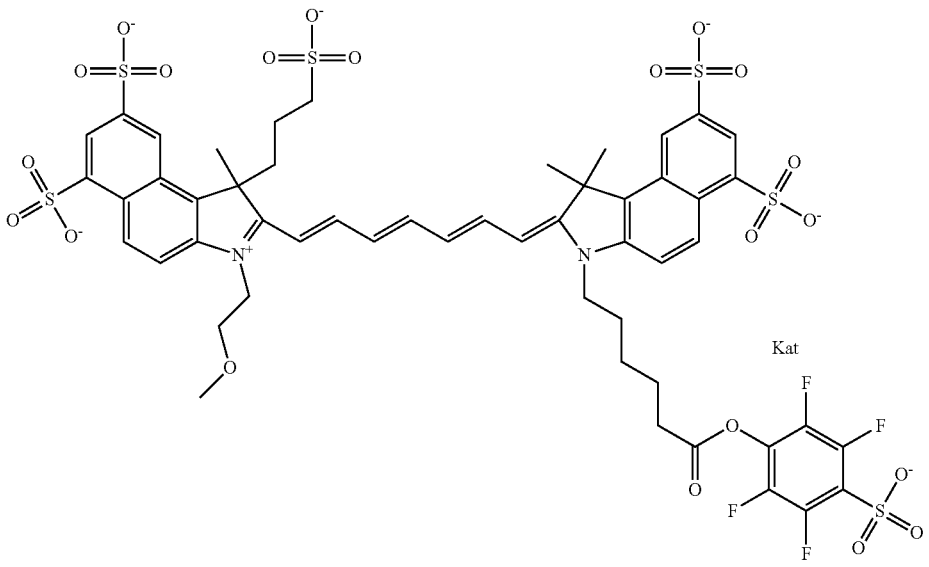


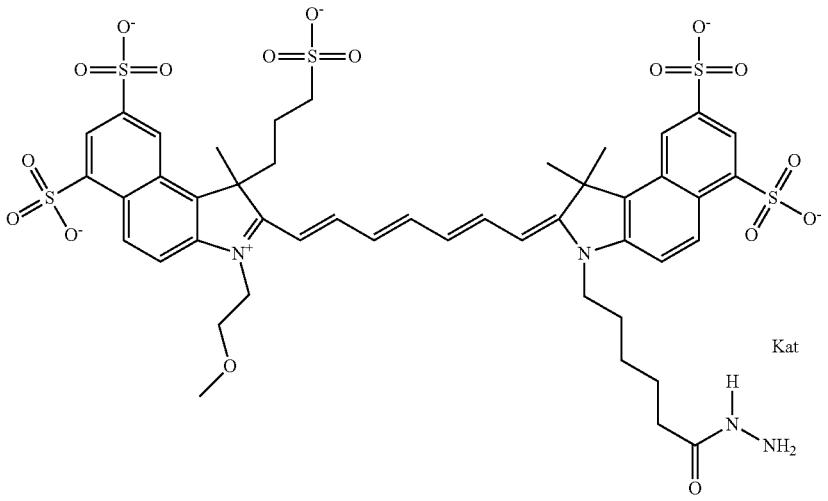
One non-limiting example of an activated 779 Compound 1 is a tetrafluorophenyl (TFP)-ester form of 779 Compound 1, shown below:



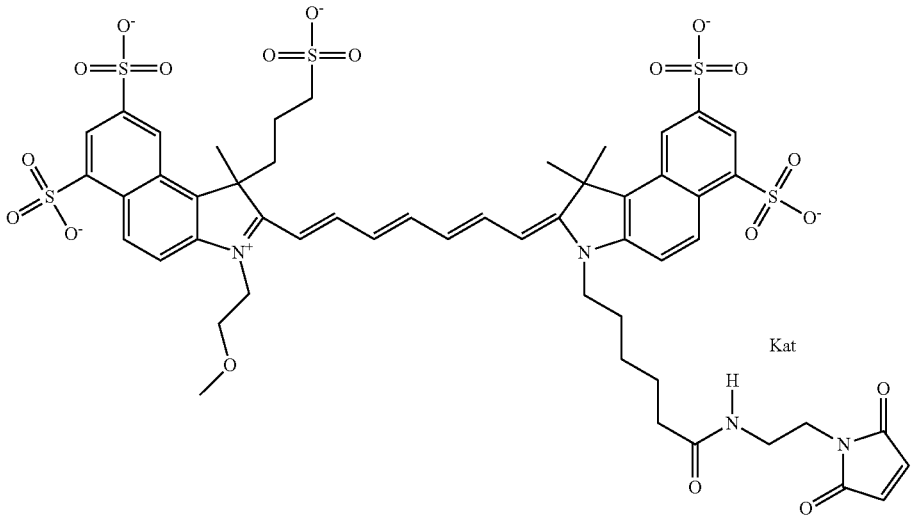
One non-limiting example of an activated 779 Compound 1 is a sulfotetrafluorophenyl (STP)-ester form of 779 Compound 1, shown below:



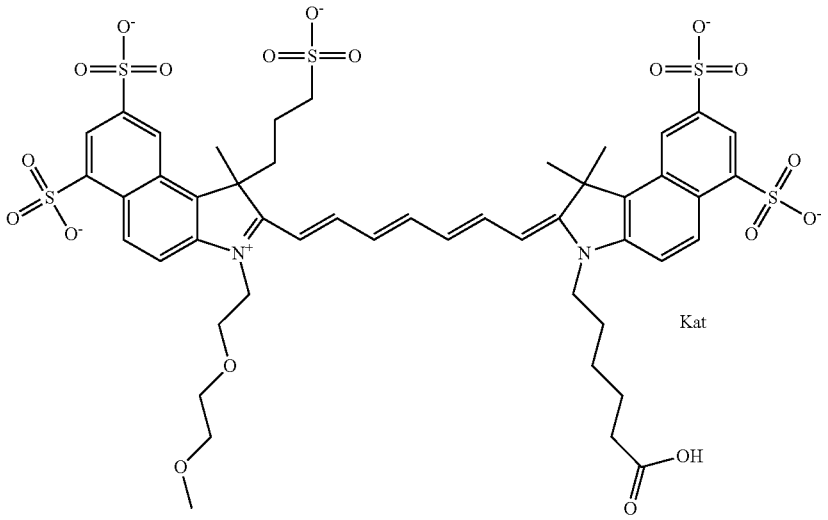
One non-limiting example of an activated 779 Compound 1 is a hydrazide form of 779 Compound 1, shown below:



One non-limiting example of an activated 779 Compound 1 is a maleimide form of 779 Compound 1, shown below:



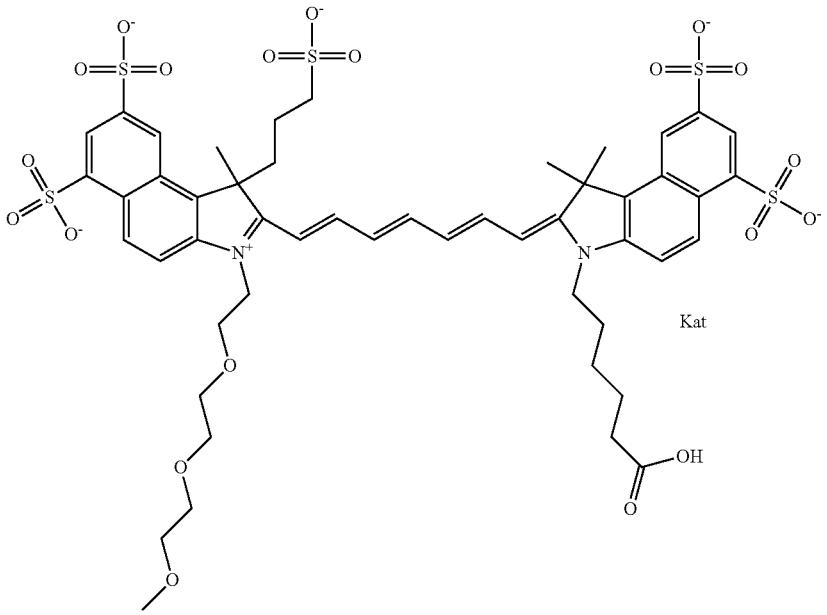
In one embodiment, the compound is 779 Compound 2



779 Compound 2 (6-((E)-2-((2E,4E,6E)-7-(3-(2-(2-methoxyethoxy)ethyl)-1-methyl-6,8-disulfonato-1-(3-sulfonatopropyl)-1H-benzo[e]indol-3-ium-2-yl)hepta-2,4,6-trien-1-ylidene)-1,1-dimethyl-6,8-disulfonato-1H-benzo[e]indol-3(2H)-yl)hexanoate) contains a diethylene glycol on the indole N of the left heterocycle. The methyl group on the ethylene glycol prevents the terminal —OH from oxidation. Oxidation is known to occur, over time, on an unprotected PEG terminus. Adding a methyl ether provides this protection, and

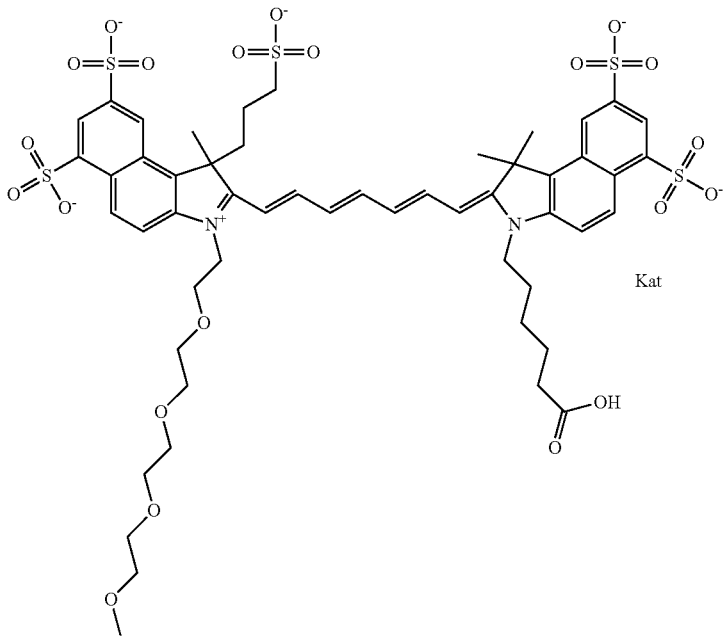
prevents reaction with electrophilic reactive groups. For functional assays, 779 Compound 2 is activated as described above.

In one embodiment, the compound is 779 Compound 3



779 Compound 3 (6-((E)-2-((2E,4E,6E)-7-(3-(2-(2-(2-methoxyethoxy)ethoxy)ethyl)-1-methyl-6,8-disulfonato-1-(3-sulfonatopropyl)-1H-benzo[e]indol-3-ium-2-yl)hepta-2,4,6-trien-1-ylidene)-1,1-dimethyl-6,8-disulfonato-1H-benzo[e]indol-3(2H)-yl)hexanoate) contains a (poly) ethylene glycol on the indole N of the left heterocycle. The methyl group on the ethylene glycol prevents the terminal —OH from oxidation. Oxidation is known to occur, over time, on an unprotected PEG terminus. Adding a methyl ether provides this protection, and prevents reaction with electrophilic reactive groups. For functional assays, 779 Compound 3 is activated as described above.

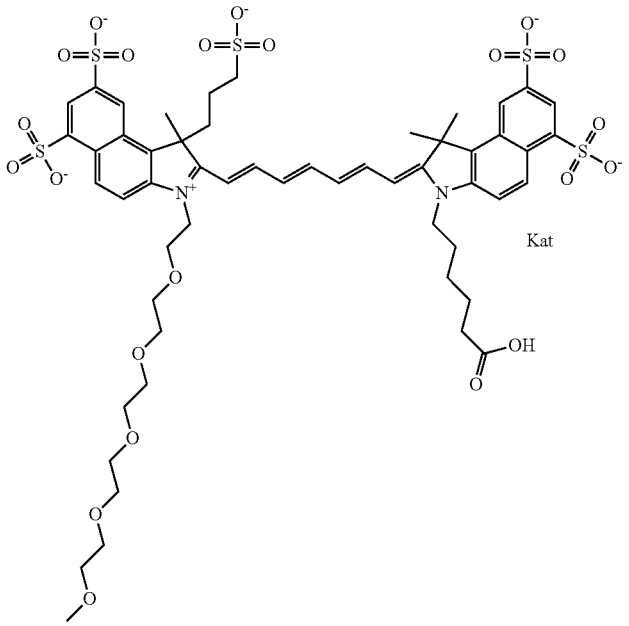
In one embodiment, the compound is 779 Compound 4



779 Compound 4 (6-((E)-1,1-dimethyl-2-((2E,4E,6E)-7-(1-methyl-6,8-disulfonato-1-(3-sulfonatopropyl)-3-(2,5,8,11-tetraoxatridecan-13-yl)-1H-benzo[e]indol-3-ium-2-yl)hepta-2,4,6-trien-1-ylidene)-6,8-disulfonato-1H-benzo[e]

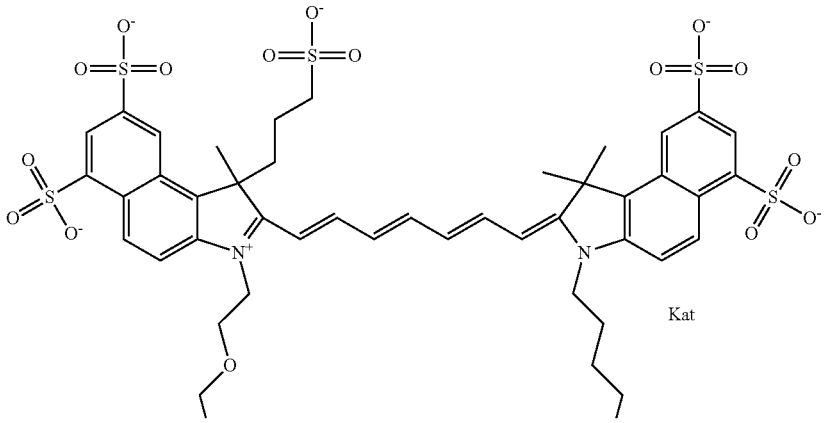
indol-3(2H)-yl)hexanoate) contains a (poly)ethylene glycol on the indole N of the left heterocycle. The methyl group on the ethylene glycol prevents the terminal —OH from oxidation. Oxidation is known to occur, over time, on an unprotected PEG terminus. Adding a methyl ether provides this protection, and prevents reaction with electrophilic reactive groups. For functional assays, 779 Compound 4 is activated as described above.

In one embodiment, the compound is 779 Compound 5



779 Compound 5 (6-((E)-2-((2E,4E,6E)-7-(3-(2,5,8,11,14-pentaoxahexadecan-16-yl)-1-methyl-6,8-disulfonato-1-(3-sulfonatopropyl)-1H-benzo[e]indol-3-ium-2-yl)hepta-2,4,6-trien-1-ylidene)-1,1-dimethyl-6,8-disulfonato-1H-benzo[e]indol-3(2H)-yl)hexanoate) contains a (poly) ethylene glycol on the indole N of the left heterocycle. The methyl group on the ethylene glycol prevents the terminal —OH from oxidation. Oxidation is known to occur, over time, on an unprotected PEG terminus. Adding a methyl ether provides this protection, and prevents reaction with electrophilic reactive groups. For functional assays, 779 Compound 5 is activated as described above.

In one embodiment, the compound is 779 Compound 6



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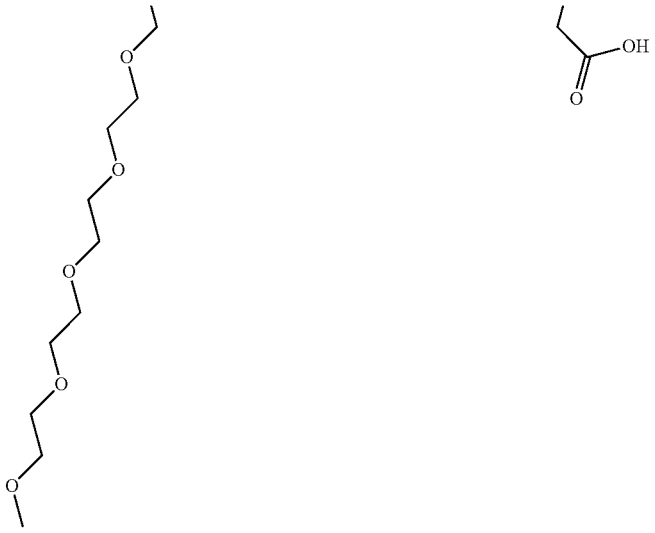
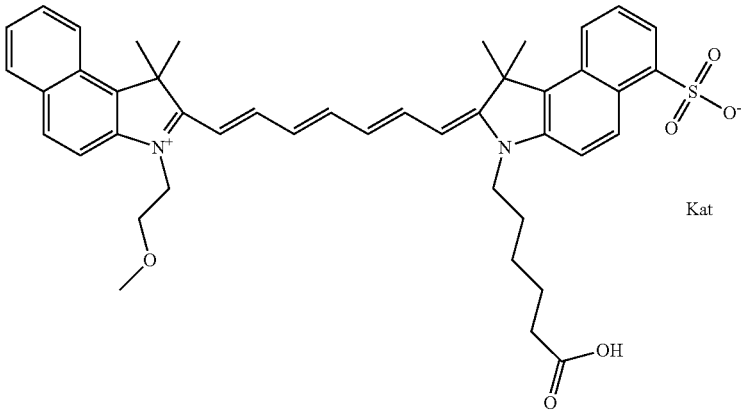


779 Compound 6 (6-((E)-1,1-dimethyl-2-((2E,4E,6E)-7-(1-methyl-3-(2,5,8,11,14,17-hexaoxanonadecan-19-yl)-6,8-disulfonato-1-(3-sulfonatopropyl)-1H-benzo[e]indol-3-ium-2-yl)hepta-2,4,6-trien-1-ylidene)-6,8-disulfonato-1H-benzo[e]indol-3(2H)-yl)hexanoate) contains a (poly)ethylene glycol on the indole N of the left heterocycle. The methyl group on the ethylene glycol prevents the terminal —OH from oxidation. Oxidation is known to occur, over time, on an unprotected PEG terminus. Adding a methyl ether provides this protection, and prevents reaction with electrophilic reactive groups. For functional assays, 779 Compound 6 is activated as described above.

In embodiments, the degree and/or location of sulfonation is varied to, e.g., vary the compound's degree of hydroplilicity or hydrophobicity. One non-limiting example is a monosulfonate form of 779 Compound 1, shown below:



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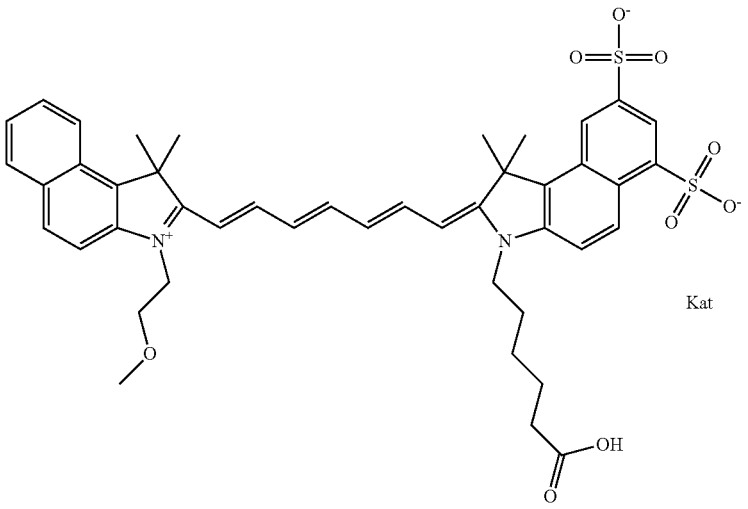
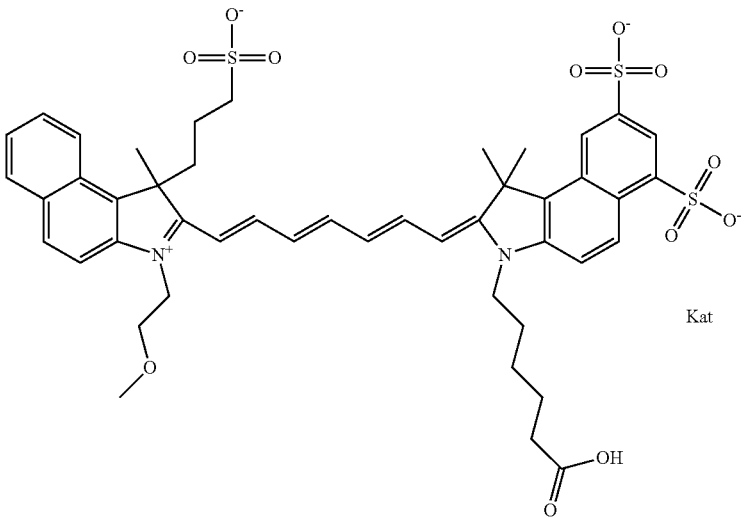
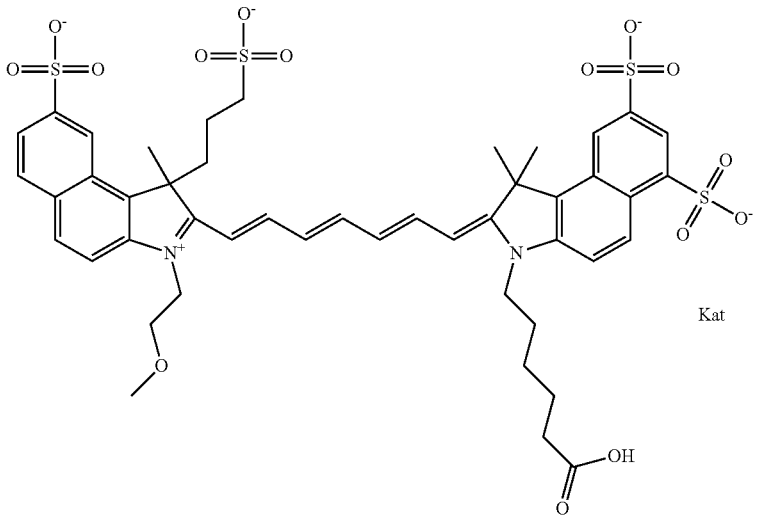
One non-limiting example is a disulfonate form of 779 Compound 1, shown below:



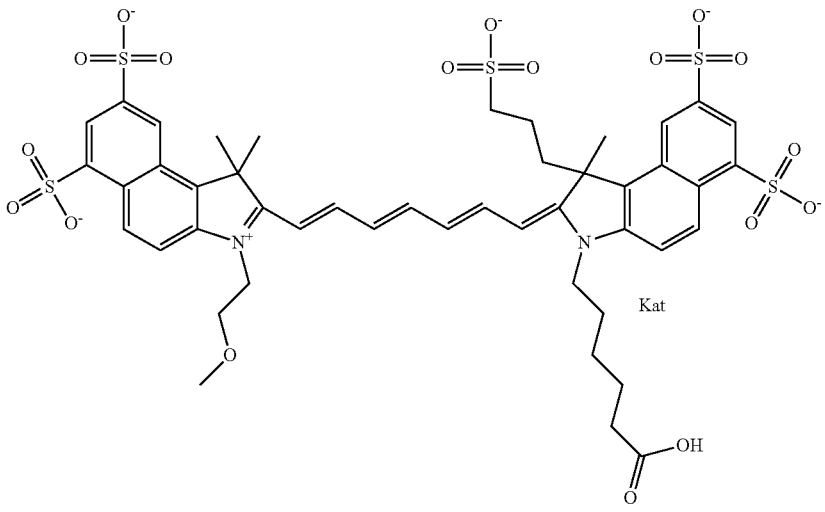
One non-limiting example is a trisulfonate form of 779 Compound 1, shown below:



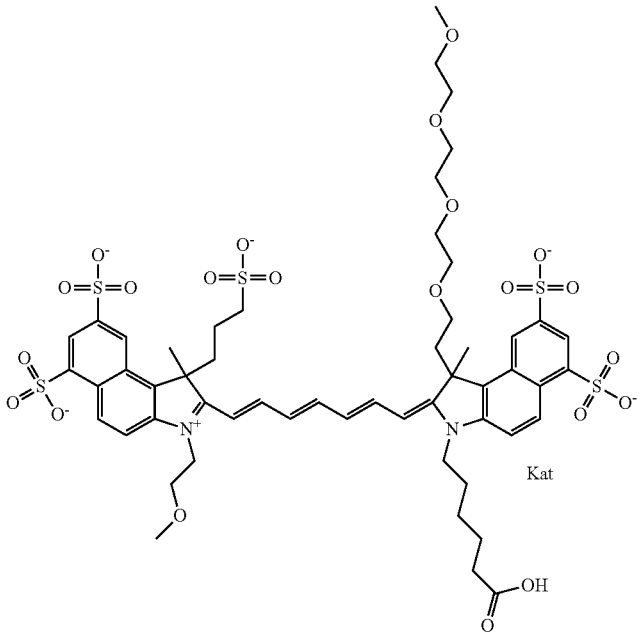
One non-limiting example is a tetrasulfonate form of 779 Compound 1, shown below:



One non-limiting example is a pentasulfonate form of 779 Compound 1, shown below:

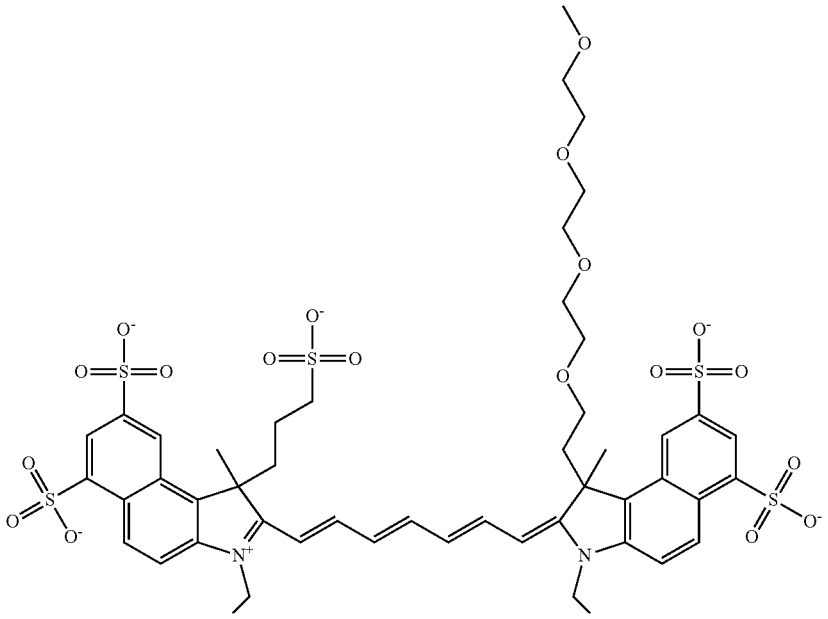


In one embodiment, the compound is 779 Compound 1/2 (PEG_4)



779 Compound 1/2 (PEG_4) (2-((1E,3E,5E,7E)-7-(3-(5-carboxypentyl)-1-methyl-6,8-disulfonato-1-(2,5,8,11-tetraoxatridecan-13-yl)-1H-benzo[e]indol-2(3H)-ylidene) hepta-1,3,5-trienyl)-3-(2-methoxyethyl)-1-methyl-1-(3-sulfonatopropyl)-1H-benzo[e]indolium-6,8-disulfonate) contains an ethylene glycol on the indole N of the left heterocycle, i.e., a methylated ethylene glycol and a PEG_4 group on the indole C. The methyl group on the ethylene glycol prevents the terminal —OH from oxidation. Oxidation is known to occur, over time, on an unprotected PEG terminus. Adding a methyl ether provides this protection, and prevents reaction with electrophilic reactive groups.

In embodiments, e.g., for functional assays, the inventive compounds are activated. Activation of the compound adds a chemical moiety such that the compound is in a form that can be conjugated to a biological moiety. Examples of chemical moieties for activation are described below with reference to activation of 779 Compound 1/2, but one skilled in the art appreciates that activation is not limited to these examples. One non-limiting example of an activated compound is the NHS-ester of 779 Compound 1/2 (PEG_4), shown below:



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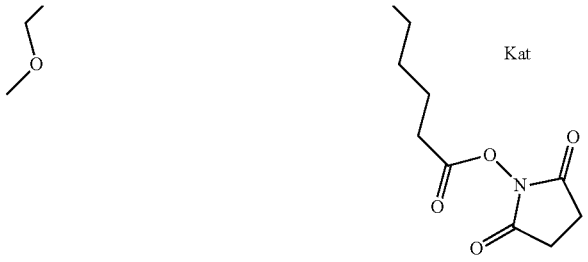
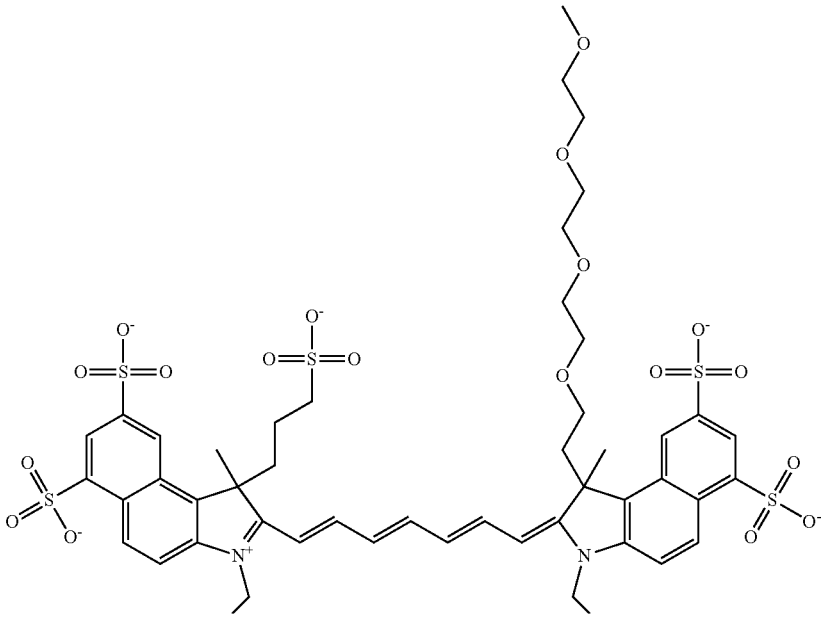
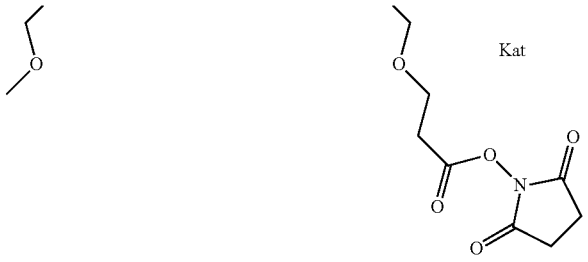
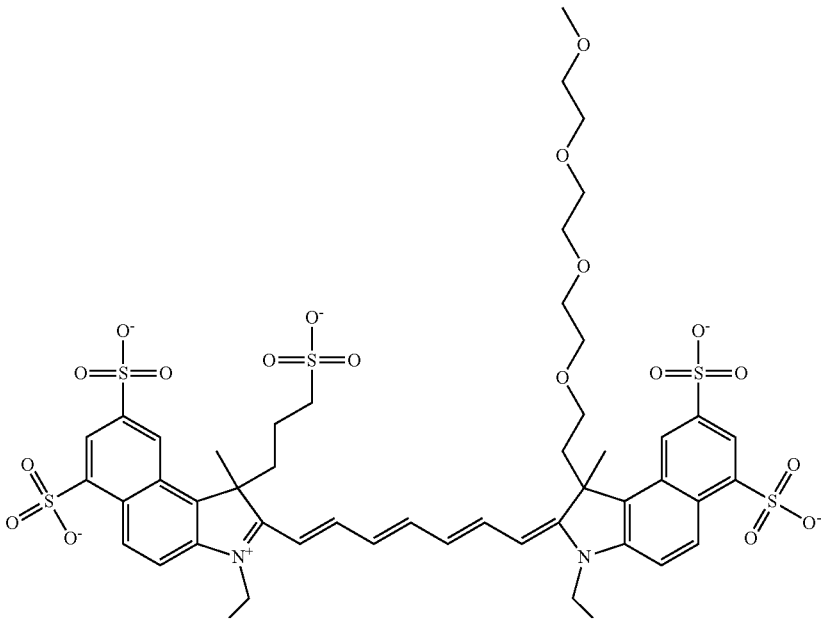


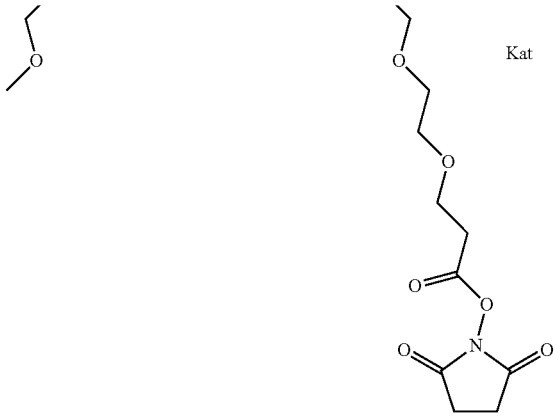
One non-limiting example of a NHS-ester of 779 Compound 1/3 (PEG_4), according to general formula III, where m=1 and p=1, is shown below:



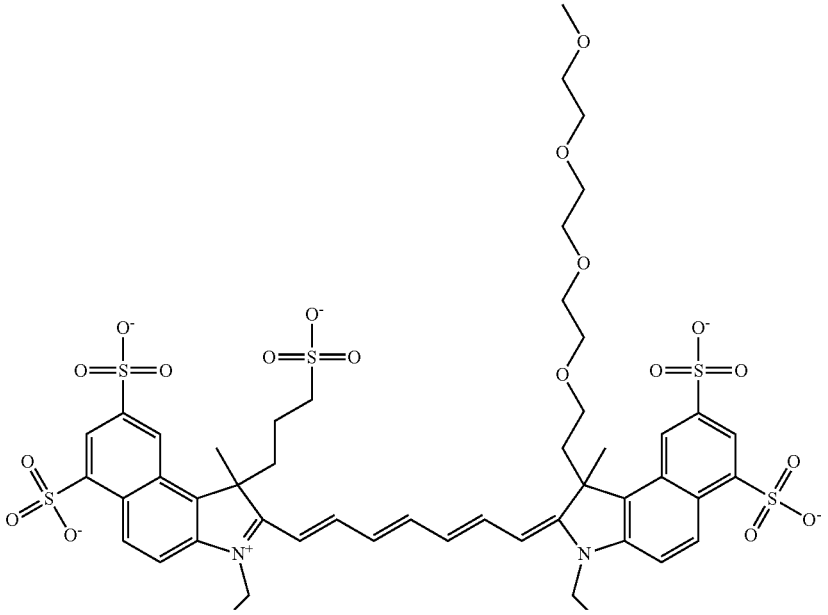


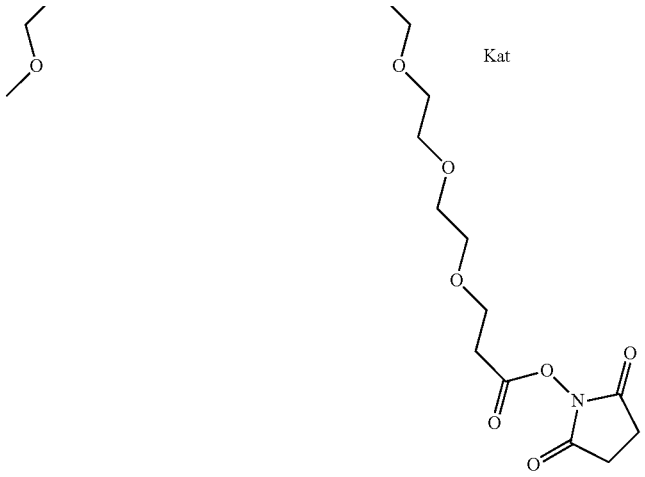
One non-limiting example of a NHS-ester of 779 Compound 1/3 (PEG_4), according to general formula III, where m=1 and p=2, is shown below:



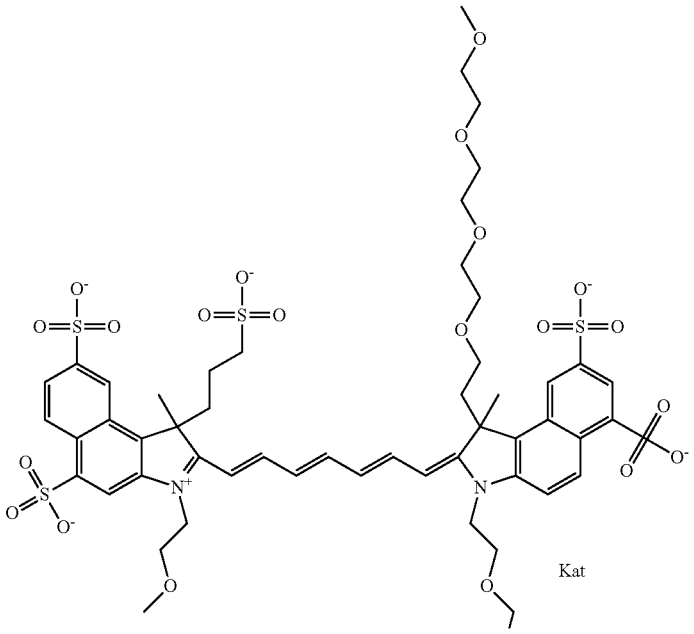


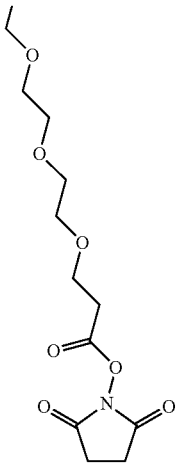
One non-limiting example of a NHS-ester of 779 Compound 1/3 (PEG_4), according to general formula III, where m=1 and p=3, is shown below:



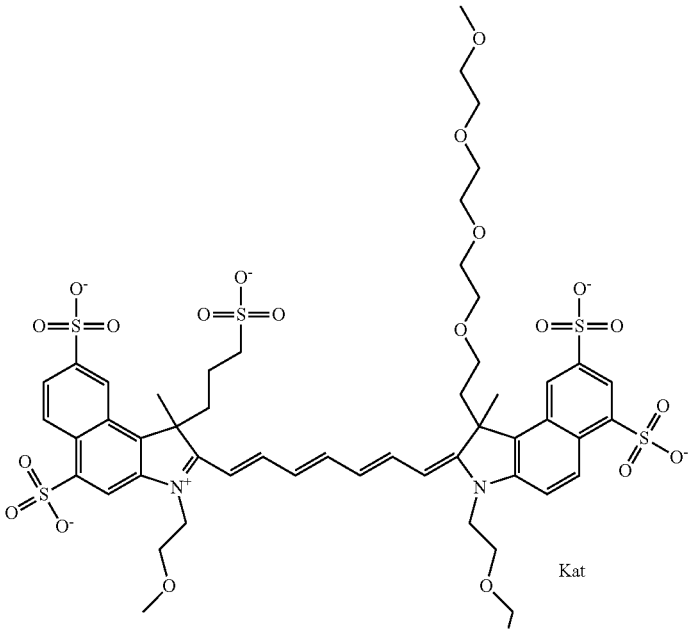


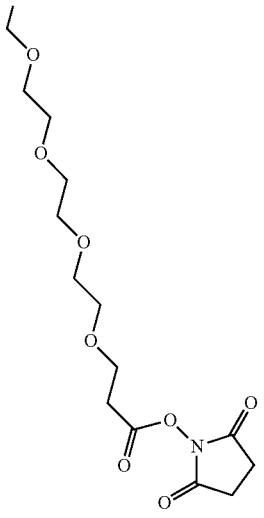
One non-limiting example of a NHS-ester of 779 Compound 1/3 (PEG_4), according to general formula III, where m=1 and p=4, is shown below:



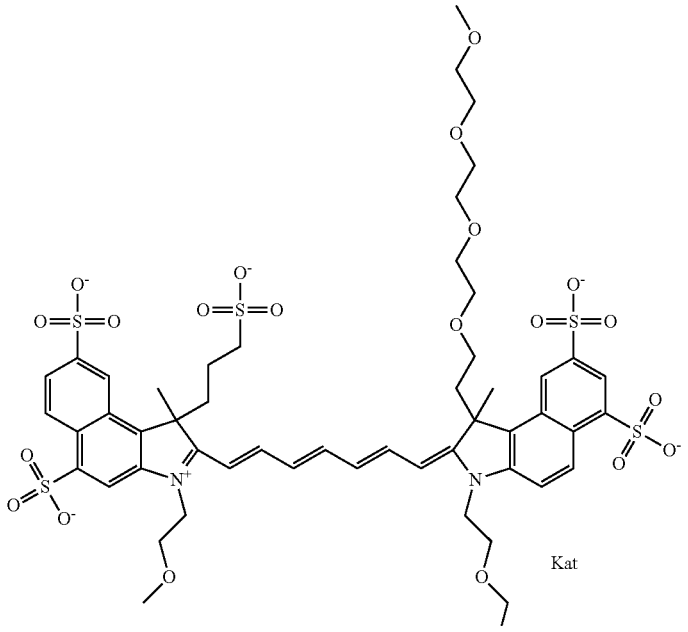


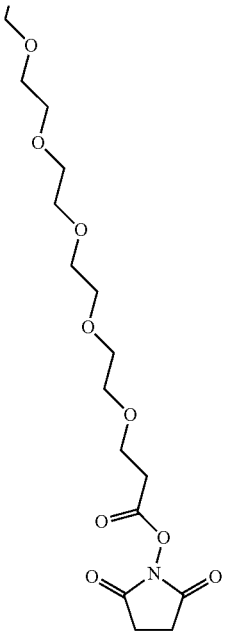
One non-limiting example of a NHS-ester of 779 Compound 1/3 (PEG_4), according to general formula where m=1 and p=5, is shown below:



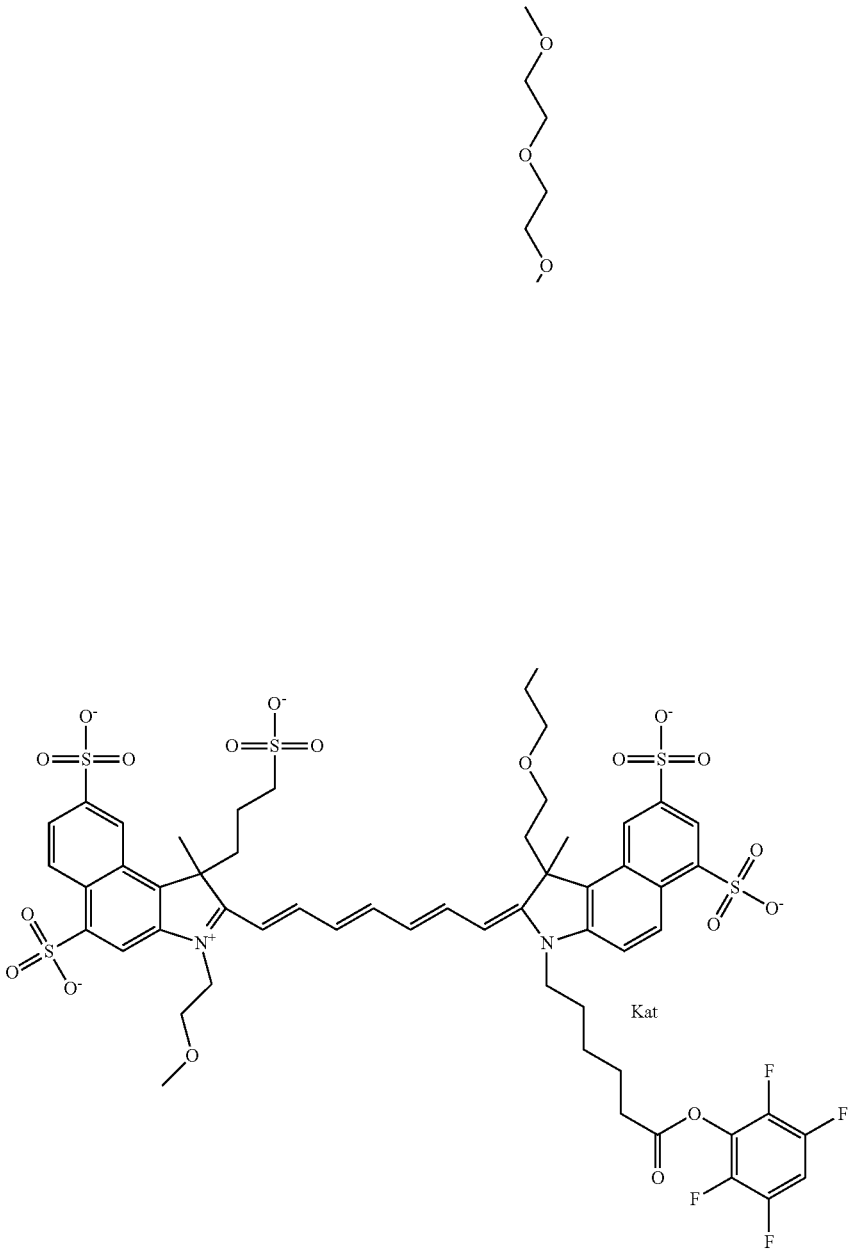


One non-limiting example of a NHS-ester of 779 Compound 1/3 (PEG_4), according to general formula III, where m=1 and p=6, is shown below:





One non-limiting example of an activated 779 Compound 1/2 (PEG_4) is a tetrafluorophenyl (TFP)-ester form of 779 Compound 1, shown below:



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One non-limiting example of an activated 779 Compound 1/2 (PEG_4) is a sulfotetrafluorophenyl (STP)-ester form of 779 Compound 1/2, shown below:

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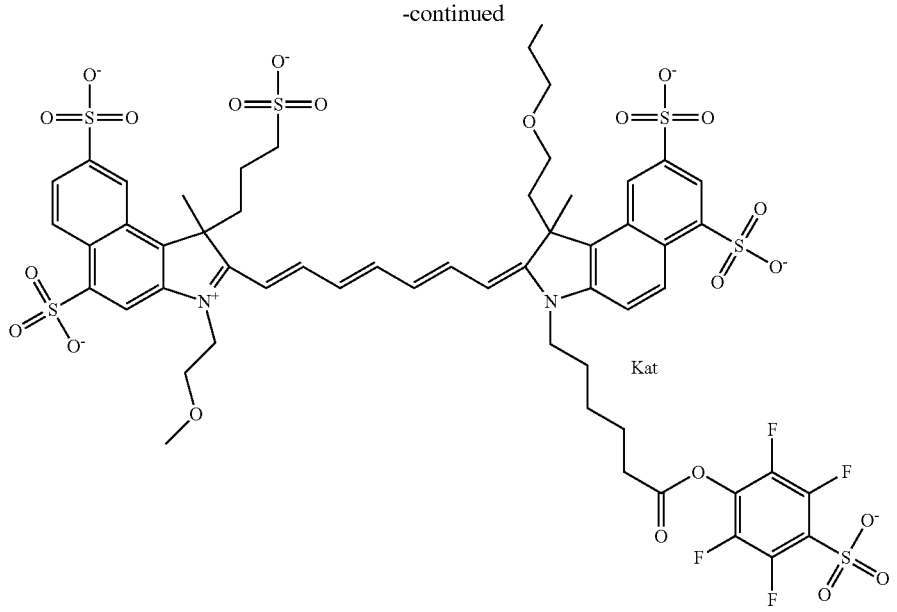
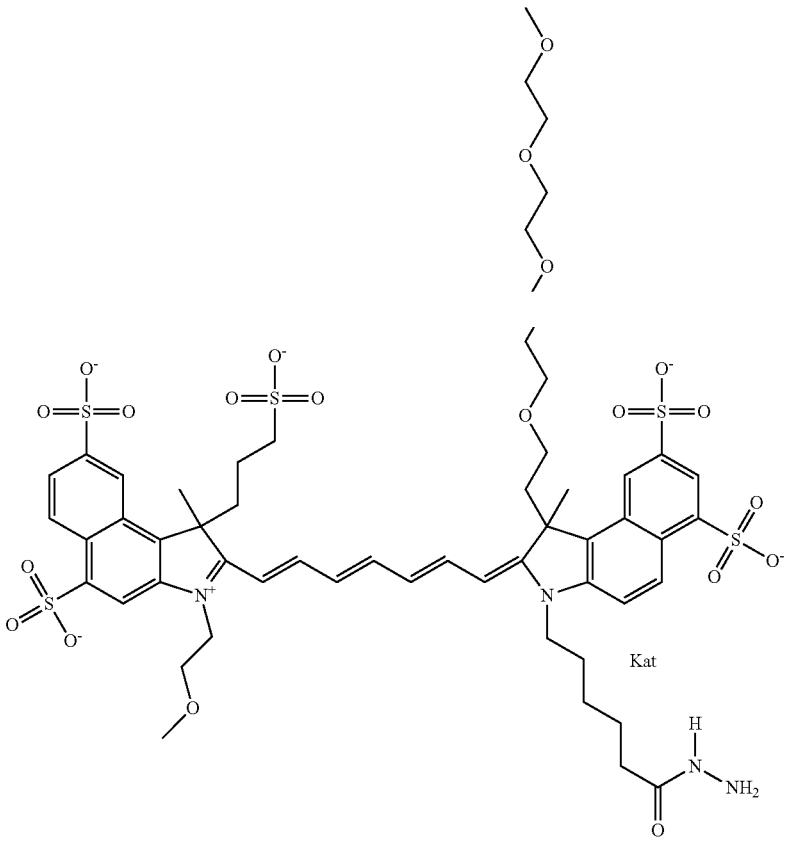
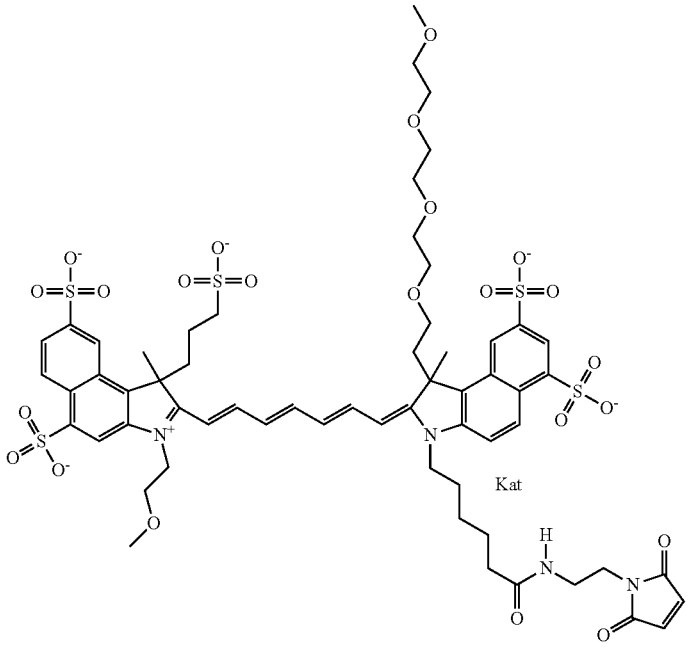


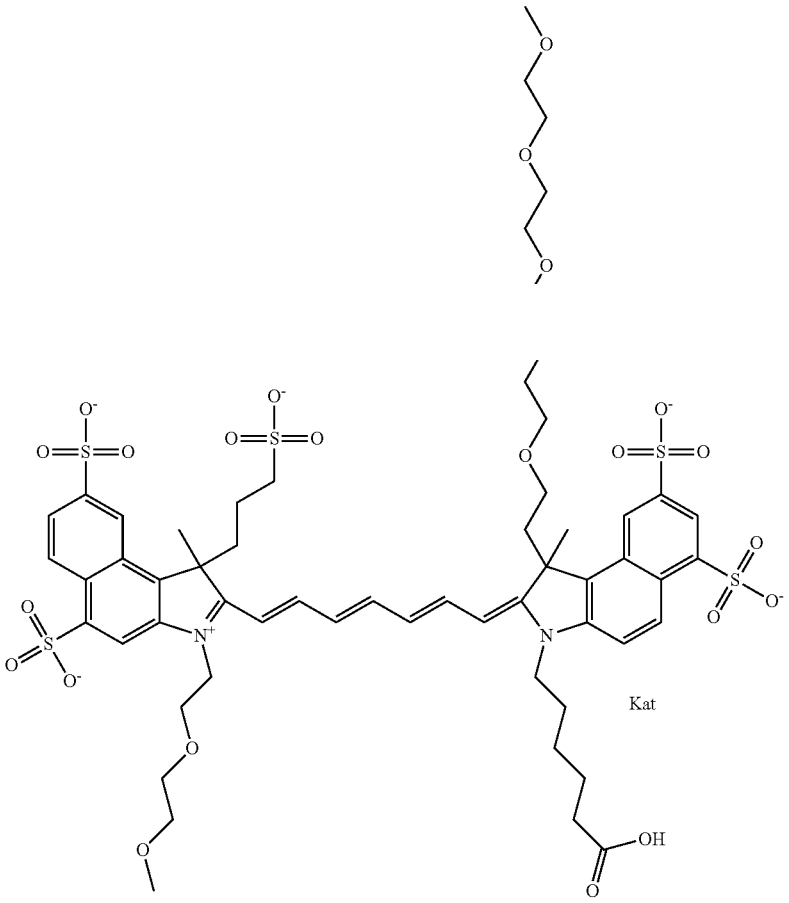
One non-limiting example of an activated 779 Compound 1/2 (PEG_4) is a hydrazide form of 779 Compound 1/2, shown below:



One non-limiting example of an activated 779 Compound 1/2 (PEG_4) is a maleimide form of 779 Compound 1/2, shown below:

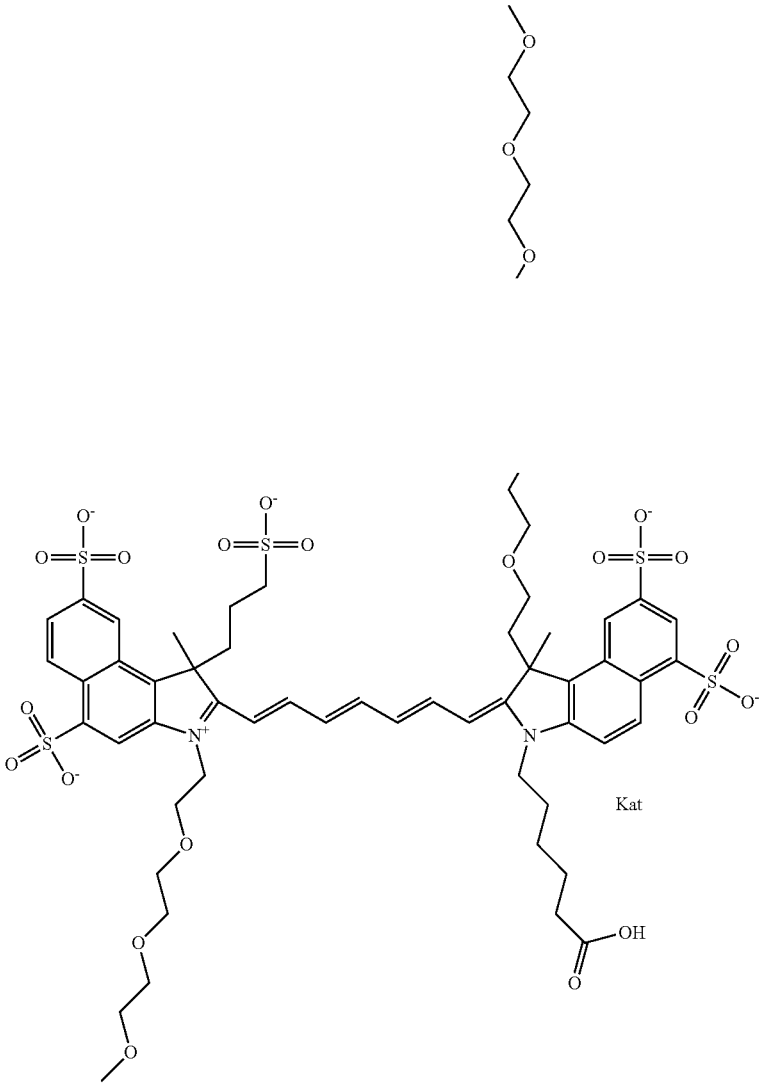


In one embodiment, the compound is 779 Compound 2/2 (PEG_4)



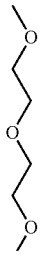
779 Compound 2/2 (PEG_4) (2-((1E,3E,5E,7E)-7-(3-(5-carboxypentyl)-1-methyl-6,8-disulfonato-1-(2,5,8,11-tetraoxatridecan-13-yl)-1H-benzo[e]indol-2(3H)-ylidene) hepta-1,3,5-trienyl)-3-(2-(2-methoxyethoxy)ethyl)-1-methyl-1-(3-sulfonatopropyl)-1H-benzo[e]indolium-6,8-disulfonate) contains a diethylene glycol on the indole N of the left heterocycle and a PEG_4 group on the indole C. The methyl group on the (poly)ethylene glycol prevents the terminal —OH from oxidation. Oxidation is known to occur, over time, on an unprotected PEG terminus. Adding a methyl ether provides this protection, and prevents reaction with electrophilic reactive groups. For functional assays, 779 Compound 2/2 (PEG_4) is activated as described above.

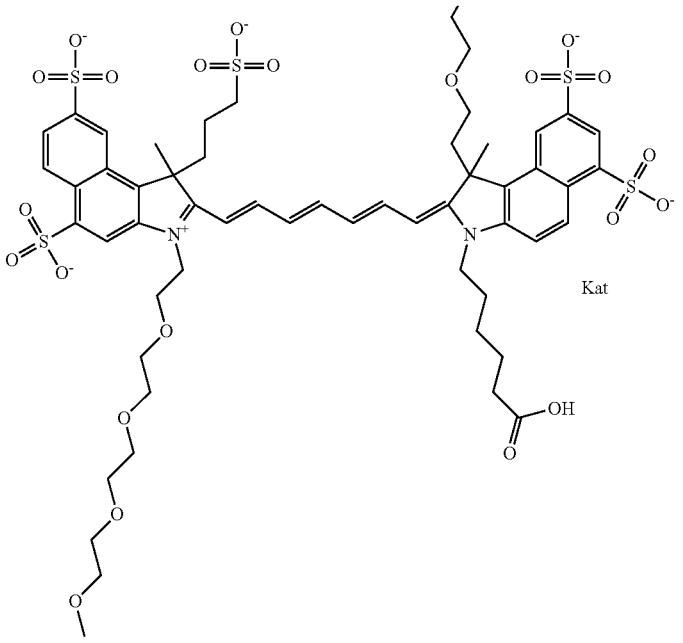
In one embodiment, the compound is 779 Compound 3/2 (PEG_4)



779 Compound 3/2 (PEG_4) (2-((1E,3E,5E,7E)-7-(3-(5-carboxypentyl)-1-methyl-6,8-disulfonato-1-(2,5,8,11-tetraoxatridecan-13-yl)-1H-benzo[e]indol-2(3H)-ylidene) hepta-1,3,5-trienyl)-3-(2-(2-(2-methoxyethoxy)ethoxy) ethyl)-1-methyl-1-(3-sulfonatopropyl)-1H-benzo[e] indolium-6,8-disulfonate) contains a (poly)ethylene glycol on the indole N of the left heterocycle and a PEG_4 group on the indole C. The methyl group on the (poly)ethylene glycol prevents the terminal —OH from oxidation. Oxidation is known to occur, over time, on an unprotected PEG terminus. Adding a methyl ether provides this protection, and prevents reaction with electrophilic reactive groups. For functional assays, 779 Compound 3/2 (PEG_4) is activated as described above.

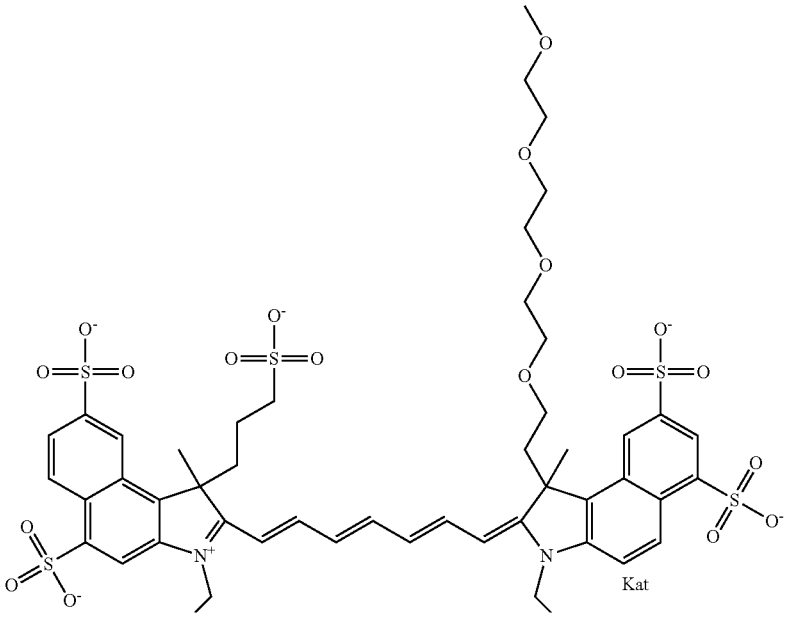
In one embodiment, the compound is 779 Compound 4/2 (PEG_4)

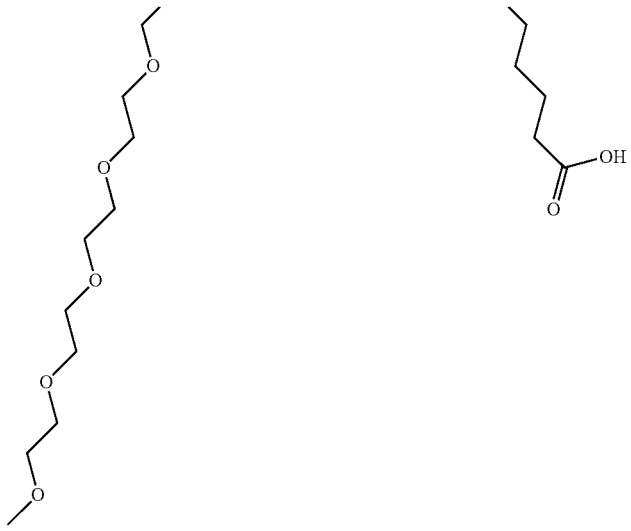




779 Compound 4/2 (PEG_4) (2-((1E,3E,5E,7E)-7-(3-(5-carboxypentyl)-1-methyl-6,8-disulfonato-1-(2,5,8,11-tetraoxatridecan-13-yl)-1H-benzo[e]indol-2(3H)-ylidene) hepta-1,3,5-trienyl)-1-methyl-1-(3-sulfonatopropyl)-3-(2,5,8,11-tetraoxatridecan-13-yl)-1H-benzo[e]indolium-6,8-disulfonate) contains a (poly)ethylene glycol on the indole N of the left heterocycle and a PEG_4 group on the indole C. The methyl group on the (poly)ethylene glycol prevents the terminal —OH from oxidation. Oxidation is known to occur, over time, on an unprotected PEG terminus. Adding a methyl ether provides this protection, and prevents reaction with electrophilic reactive groups. For functional assays, 779 Compound 4/2 (PEG_4) is activated as described above.

In one embodiment, the compound is 779 Compound 5/2 (PEG_4)

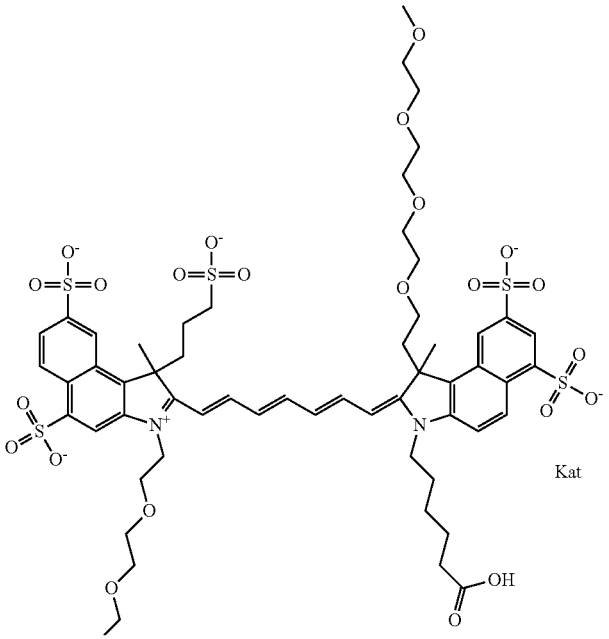


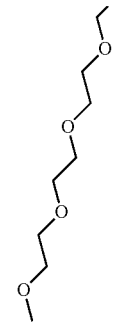


779 Compound 5/2 (PEG_4) (2-((1E,3E,5E,7E)-7-(3-(5-carboxypentyl)-1-methyl-6,8-disulfonato-1-(2,5,8,11-tetraoxatridecan-13-yl)-1H-benzo[e]indol-2(3H)-ylidene) hepta-1,3,5-trienyl)-3-(2,5,8,11,14-pentaoxahexadecan-16-yl)-1-methyl-1-(3-sulfonatopropyl)-1H-benzo[e]indolium-6,8-disulfonate) contains a (poly)ethylene glycol on the indole N of the left heterocycle and a PEG_4 group on the indole C. The methyl group on the (poly)ethylene glycol prevents the terminal —OH from oxidation. Oxidation is known to occur, over time, on an unprotected PEG terminus. Adding a methyl ether provides this protection, and prevents

reaction with electrophilic reactive groups. For functional assays, 779 Compound 5/2 (PEG_4) is activated as described above.

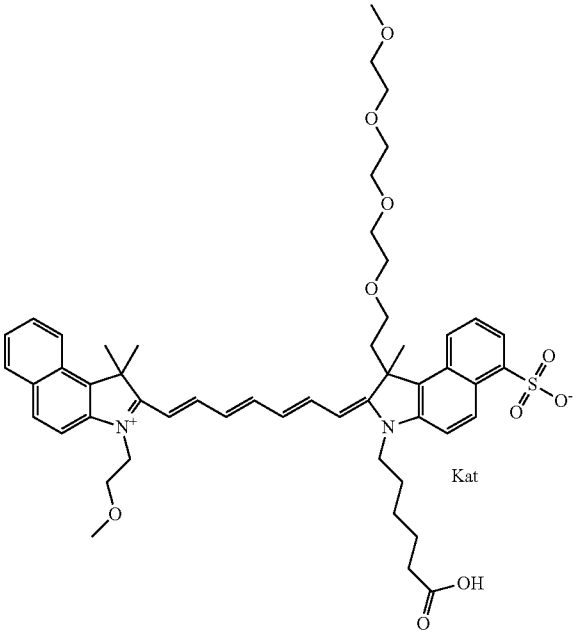
In one embodiment, the compound is 779 Compound 6/2 (PEG_4)



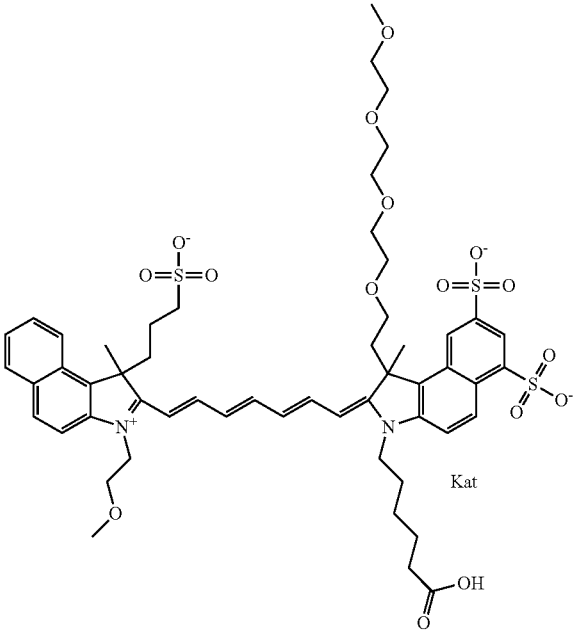


779 Compound 6/2 (PEG_4) (2-((1E,3E,5E,7E)-7-(3-(5-carboxypentyl)-1-methyl-6,8-disulfonato-1-(2,5,8,11-tetraoxatridecan-13-yl)-1H-benzo[e]indol-2(3H)-ylidene) hepta-1,3,5-trienyl)-1-methyl-3-(2,5,8,11,14,17-hexaoxanonadecan-19-yl)-1-(3-sulfonatopropyl)-1H-benzo[e]indolium-6,8-disulfonate) contains a (poly)ethylene glycol on the indole N of the left heterocycle. The methyl group on the (poly)ethylene glycol prevents the terminal —OH from oxidation. Oxidation is known to occur, over time, on an unprotected PEG terminus. Adding a methyl ether provides this protection, and prevents reaction with electrophilic reactive groups. For functional assays, 779 Compound 6/2 (PEG_4) is activated as described above.

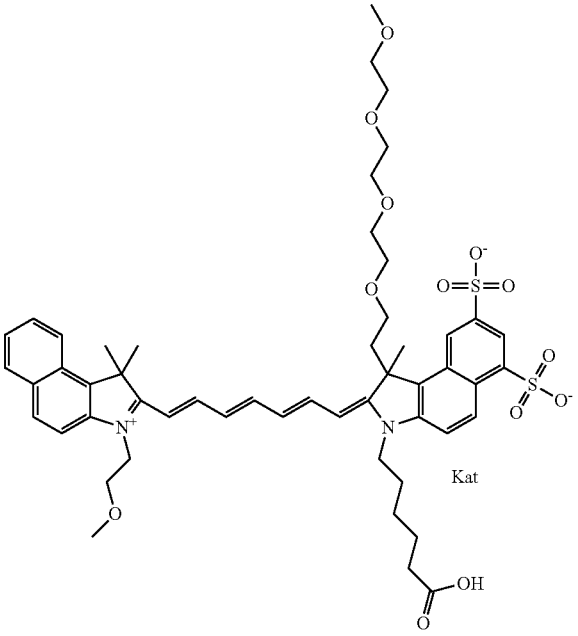
In embodiments, the degree and/or location of sulfonation is varied to, e.g., vary the compound's degree of hydroplilicity or hydrophobicity. One non-limiting example is a monosulfonate form of 779 Compound 1/2 (PEG_4), shown below:



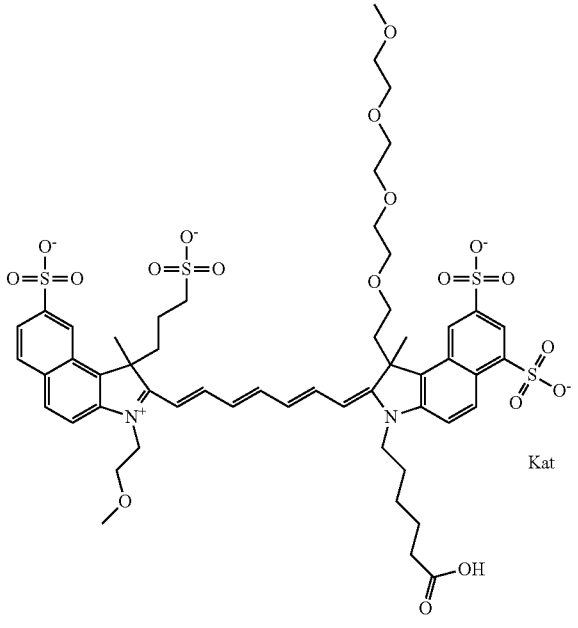
One non-limiting example is a disulfonate form of 779 Compound 1/2 (PEG_4), shown below:



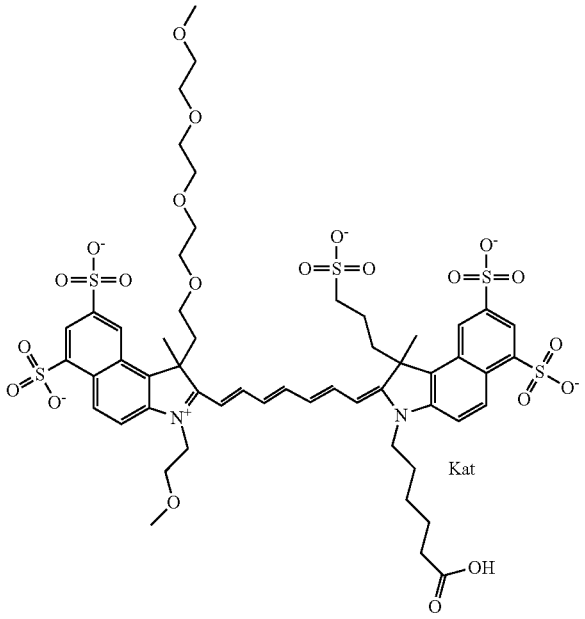
One non-limiting example is a tetrasulfonate form of 779 Compound 1/2 (PEG_4), shown below:



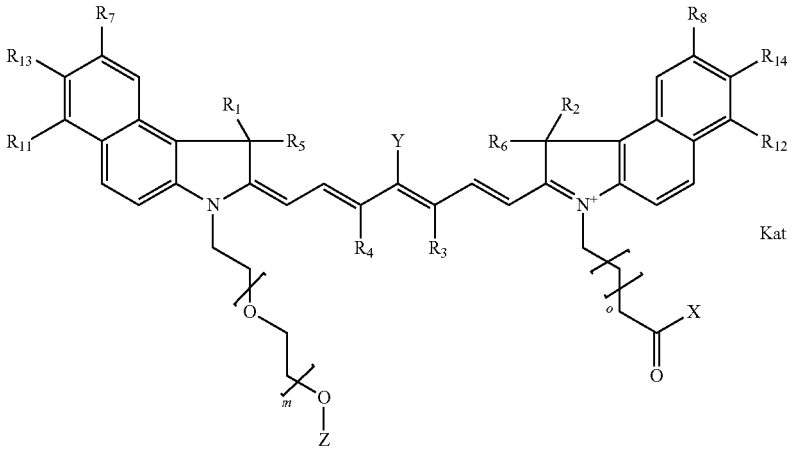
One non-limiting example is a trisulfonate form of 779 Compound 1/2 (PEG_4), shown below:



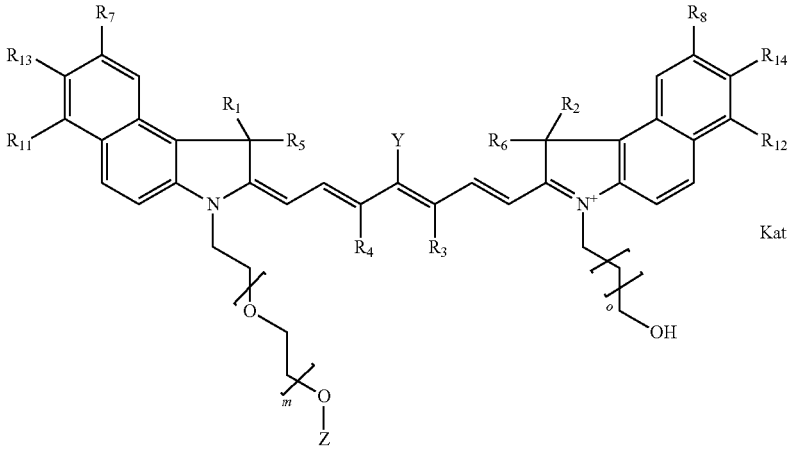
One non-limiting example is a pentasulfonate form of 779 Compound 1/2 (PEG_4), shown below:



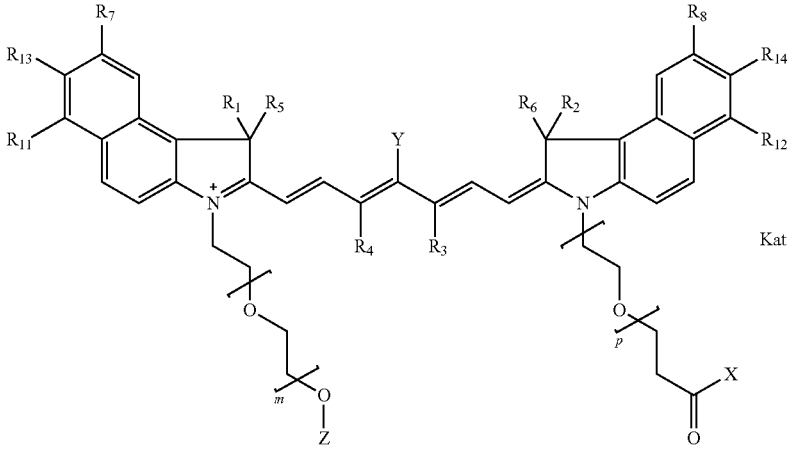
In embodiments, the compound contains one or more substitutions of the polymethine linker. In one embodiment, the compound has general formula VIa



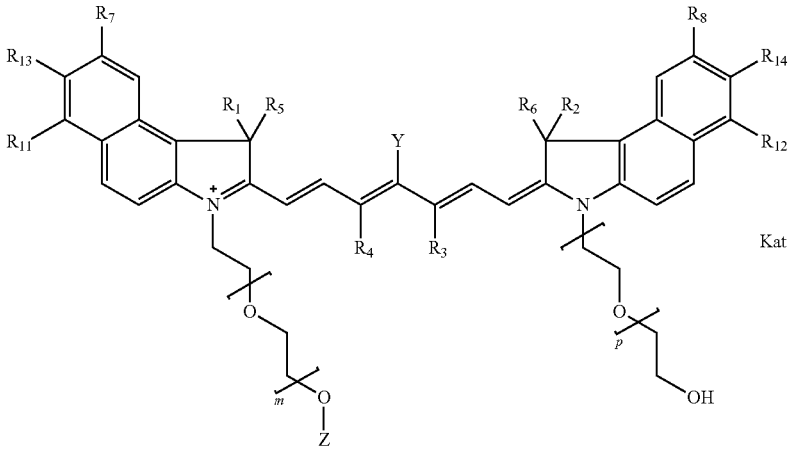
general formula VIb



general formula VIc



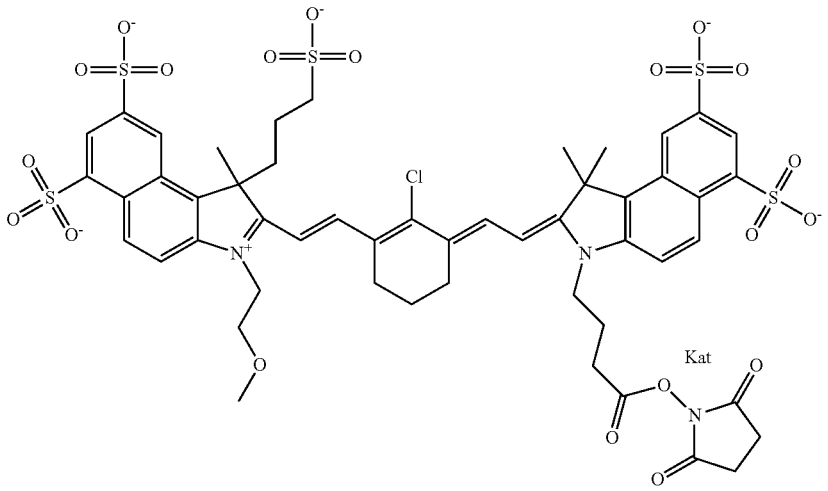
general formula VId



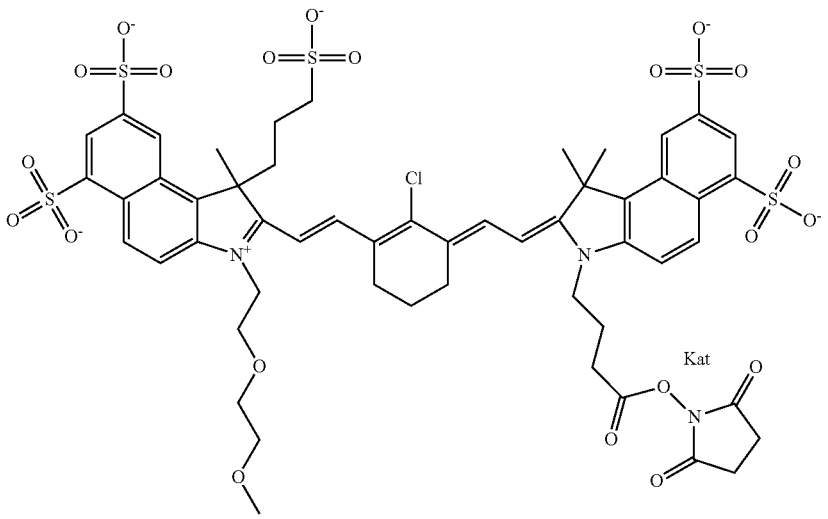
where each of R^1, R^2, R^5, and R^6 is the same or different and is independently selected from the group consisting of an aliphatic, heteroaliphatic, sulfoalkyl group, heteroaliphatic with terminal SO_3, a PEG group P—Z where P is selected from an ethylene glycol group, a diethylene glycol group, and a polyethylene glycol group, where the polyethylene glycol group is $(CH_2CH_2O)_s$, where s is an integer from 3-6 inclusive, a sulfonamide group -L-SO_2NH—P—Z, and a carboxamide group -L-CONH—P—Z, and Z is selected from H, CH_3, a CH_3 group, an alkyl group, a heteroalkyl group, or —CO—NHS; each of R^7, R^8, R^{11}, R^{12}, R^{13}, and R^{14} is the same or different and is independently selected from either H, SO_3, a PEG group P—Z where P is selected from an ethylene glycol group, a diethylene glycol group, and a polyethylene glycol group, where the polyethylene glycol group is $(CH_2CH_2O)_s$, where s is an integer from 3-6 inclusive, a sulfonamide group -L-SO2NH—P—Z, or a carboxamide group -L-CONH—P—Z, and Z is selected from H, a CH_3 group, an alkyl group, a heteroalkyl group, or —CO—NHS; X is selected from the group consisting of —OH, —SH, —NH_2, —NH—NH_2, —F, —Cl, —Br, I, —NHS (hydroxysuccinimidyl/sulfosuccinimidyl), —O-TFP (2,3,5,6-tetrafluorophenoxy), —O-STP (4-sulfo-2,3,5,6-tetrafluorophenoxy), —O-benzotriazole, -benzotriazole, —NR-L-OH, —NR-L-O-phosphoramidite, —NR-L-SH, —NR-L-NH_2, —NR-L-NH—NH_2, —NR-L-CO_2H, —NR-L-CO—NHS, —NR-L-CO-STP, —NR-L-CO-TFP, —NR-L-CO-benzotriazole, —NR-L-CHO, —NR-L-maleimide, —NR-L-NH—CO—CH2-I, imidazole, azide, —NR-L-O—NH2, and —NR-L-O—CO—NHS, where R is —H or an aliphatic or heteroaliphatic group, and L is selected from the group consisting of a divalent linear (—$(CH_2)_t$—, t=0 to 15), crossed, or cyclic alkyl group optionally substituted by at least one oxygen atom and/or sulfur atom; Kat is a number of Na^+, K^+, Ca^{2+}, ammonia, or other cation(s) needed to compensate the negative charge brought by the cyanine; m is an integer from 0 to 5 inclusive; o is an integer from 0 to 12 inclusive; p is an integer from 1 to 6 inclusive; each of R3 and R4 is the same or different and is independently hydrogen, an aliphatic group, a heteroaliphatic group, or a PEG group P—Z where P is selected from an ethylene glycol group, a diethylene glycol group, and a polyethylene glycol group, where the polyethylene glycol group is $(CH_2CH_2O)_s$, where s is an integer from 3-6 inclusive, and Z is selected from H, CH_3, a CH_3 group, an alkyl group, a heteroalkyl group, or —CO—NHS; or R3 and R4 together form a cyclic structure where R3 and R4 are joined using a divalent structural element selected from the group consisting of —$(CH_2)_q$—, —$(CH_2)_q$O$(CH_2)_{q'}$—, —$(CH_2)_q$S$(CH_2)_{q'}$—, —$(CH_2)_q$CH=CH—, and —OCH=CH— where each of q and q' is the same or different and is a integer from 2 to 6 inclusive; and Y is selected from the group consisting of hydrogen, alkyl, sulfoalkyl, fluorine, chlorine, bromine, a substituted or unsubstituted aryl-, phenoxy-, phenylmercapto function, and a PEG group P—Z where P is selected from an ethylene glycol group, a diethylene glycol group, and a polyethylene glycol group, where the polyethylene glycol group is $(CH_2CH_2O)_s$, where s is an integer from 3-6 inclusive, and Z is selected from H, CH_3, a CH_3 group, an alkyl group, a heteroalkyl group, or —CO—NHS.

In one embodiment, the compound of general formula VI wherein each of R3 and R4 is the same or different and is independently hydrogen, an aliphatic group, or a heteroaliphatic group, or R3 and R4 together form a cyclic structure where R3 and R4 are directly joined or joined using a divalent structural element selected from the group consisting of —$(CH_2)_q$— and CH=CH, where q is an integer from 1 to 2 inclusive, to result in a 3-, 4-, or 5-membered ring.

One non-limiting example is a substituted polymethine form of 779 Compound 1, shown below:

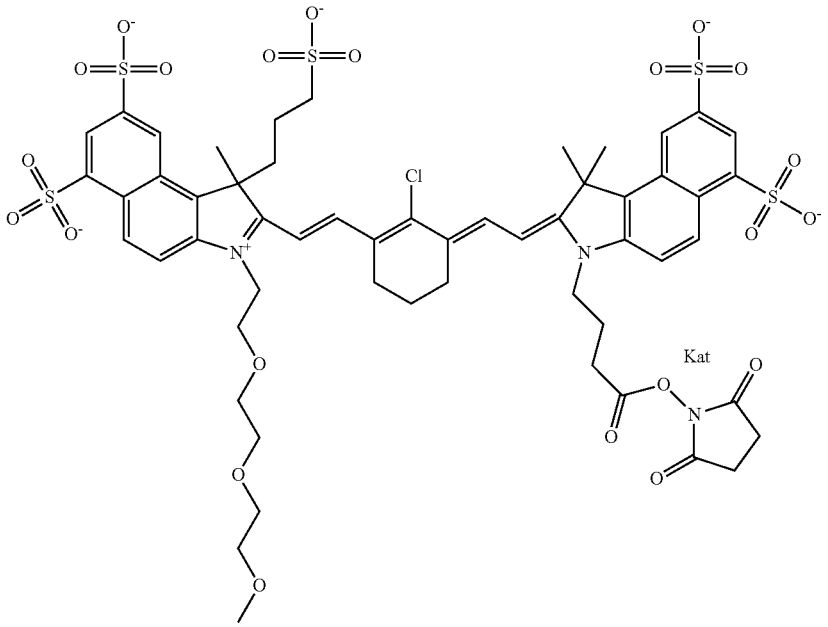


One non-limiting example is a substituted polymethine form of 779 Compound 2, shown below:



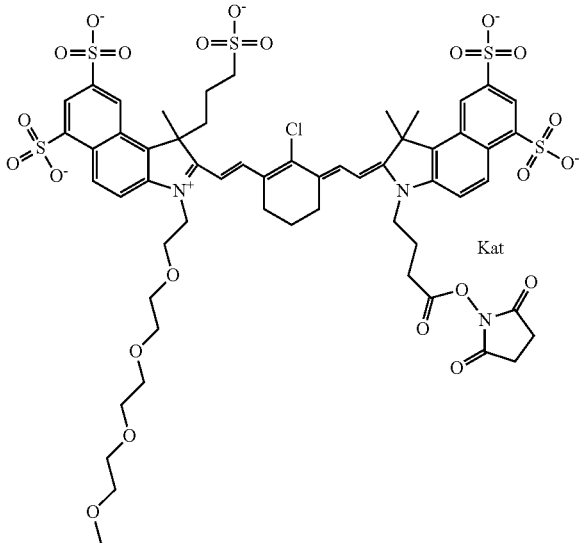
25

One non-limiting example is a substituted polymethine form of 779 Compound 3, shown below:

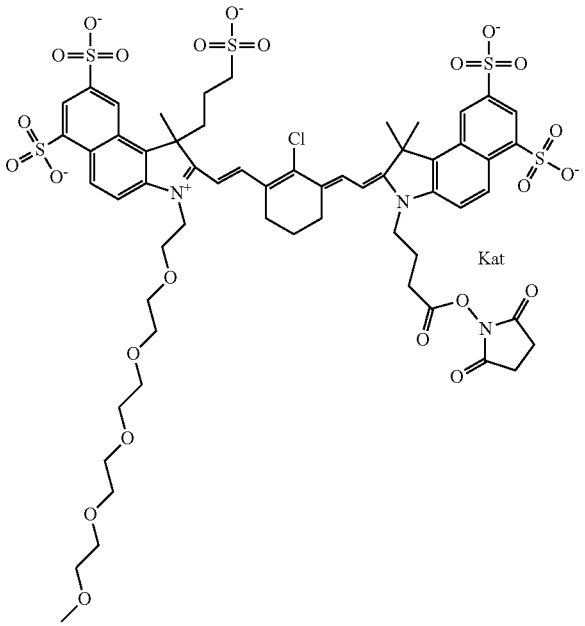


65

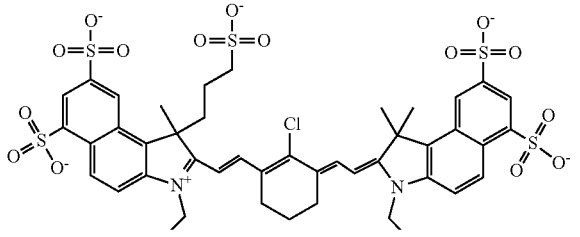
One non-limiting example is a substituted polymethine form of 779 Compound 4, shown below:



One non-limiting example is a substituted polymethine form of 779 Compound 5, shown below:



One non-limiting example is a substituted polymethine form of 779 Compound 6, shown below:



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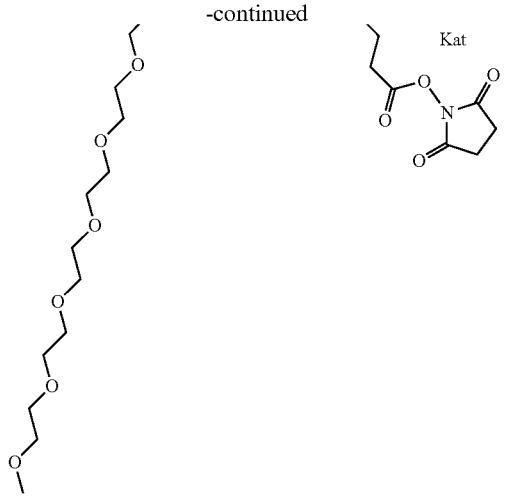
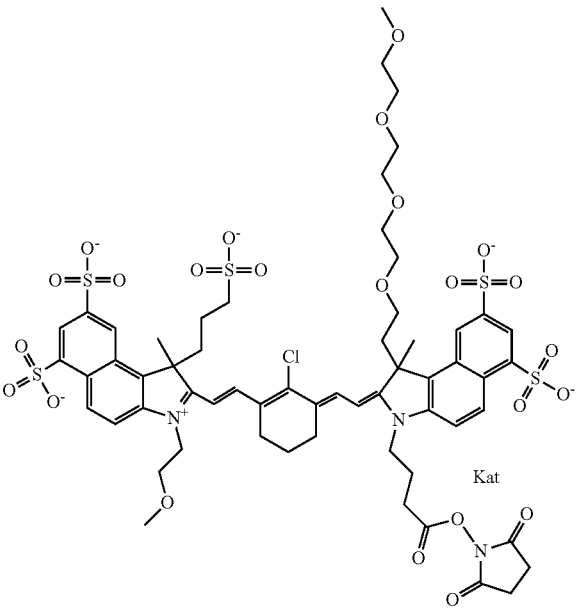
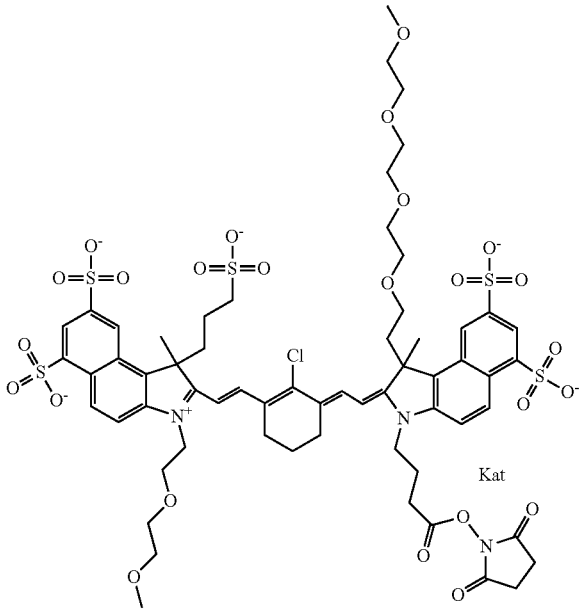


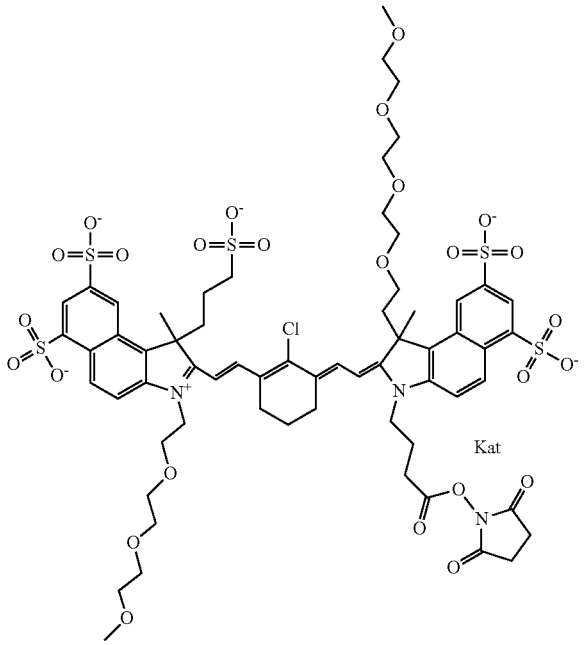
One non-limiting example is a substituted polymethine form of 779 Compound 1/2 (PEG_4), shown below:



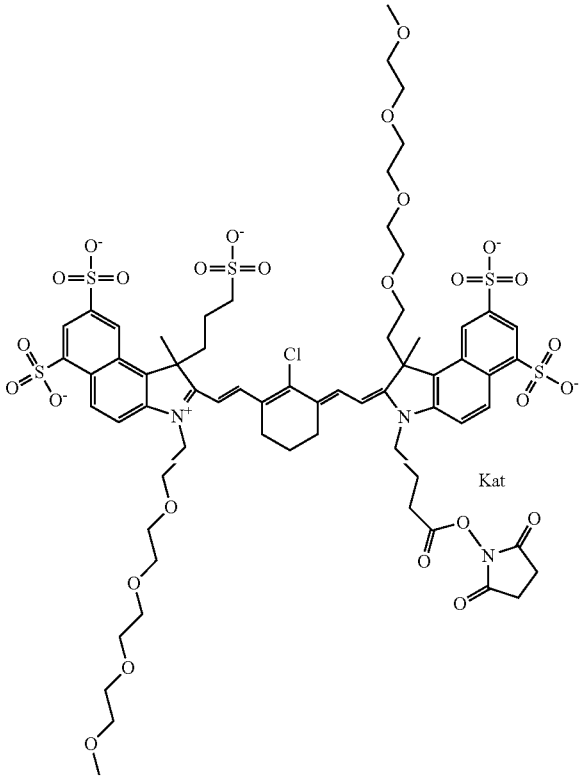
One non-limiting example is a substituted polymethine form of 779 Compound 2/2 (PEG_4), shown below:



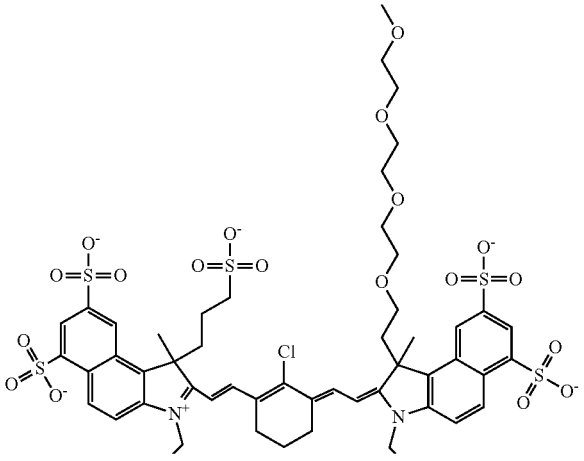
One non-limiting example is a substituted polymethine form of 779 Compound 3/2 (PEG_4), shown below:



One non-limiting example is a substituted polymethine form of 779 Compound 4/2 (PEG_4), shown below:



One non-limiting example is a substituted polymethine form of 779 Compound 5/2 (PEG_4), shown below:



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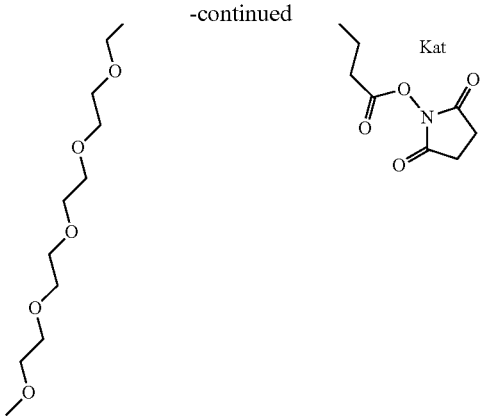

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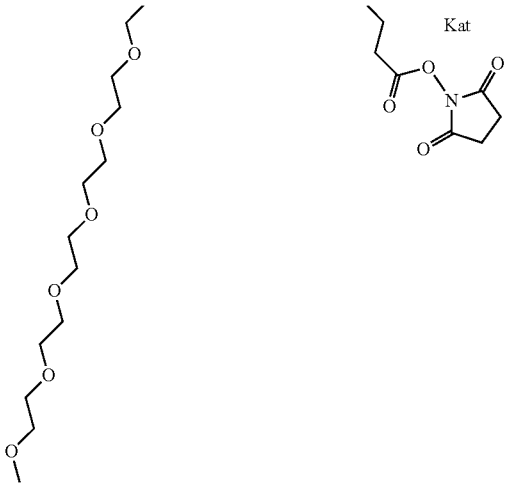
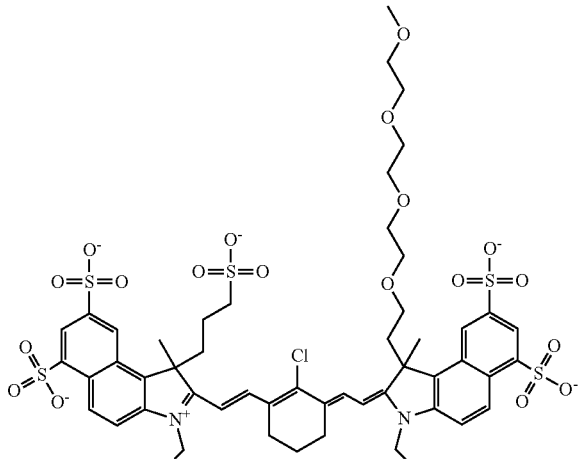
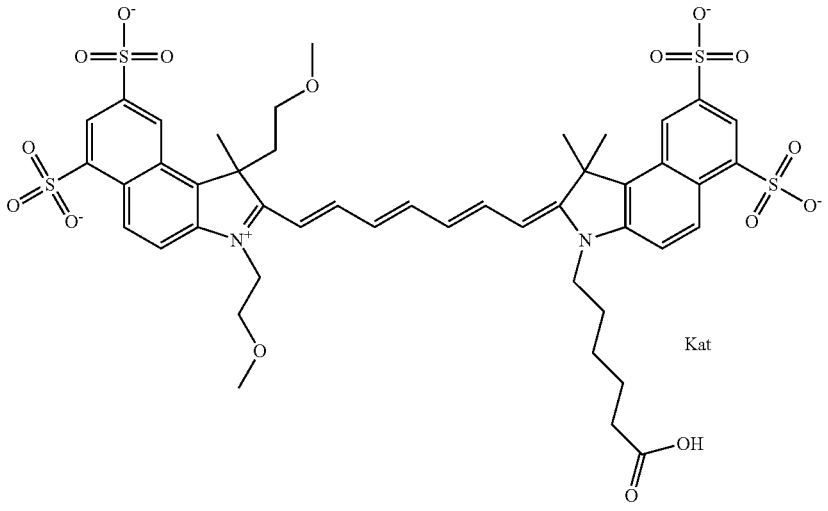


One non-limiting example is a substituted polymethine form of 779 Compound 6/2 (PEG_4), shown below:

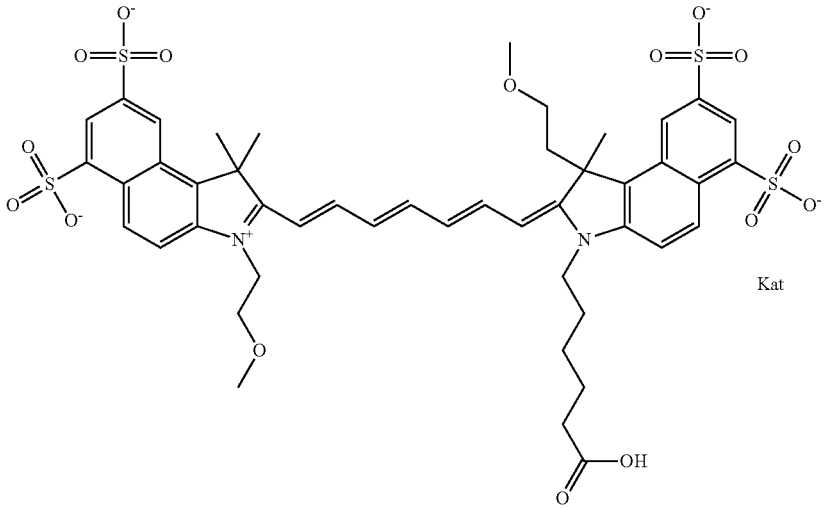


In embodiments, an ethylene glycol group, diethylene glycol group, and/or a polyethylene glycol group, collectively referred to as a PEG group unless specifically defined, may be present at position(s) in addition to such groups being present on the N atom(s) of the indole structure.

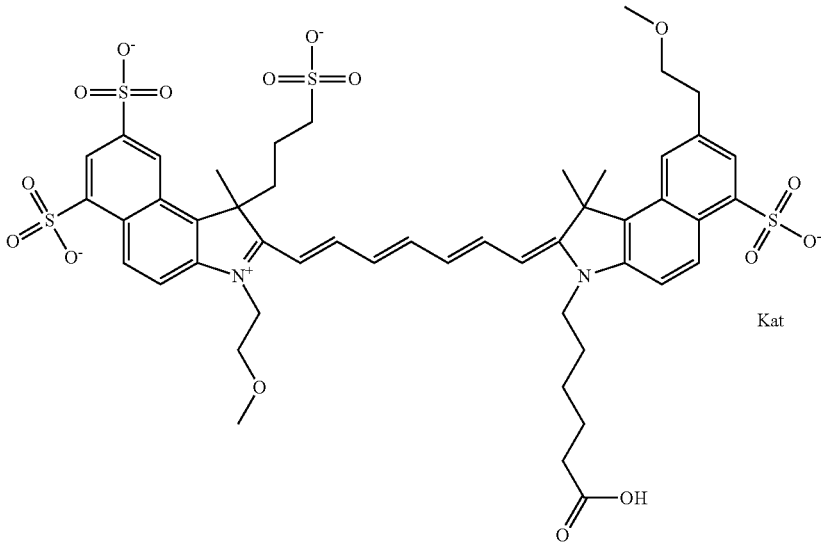
One non-limiting example of an additionally PEG-substituted compound is a 779 Compound 1/2 according to general formula II where R1 is an ethylene glycol group terminating with a methyl group, shown below:



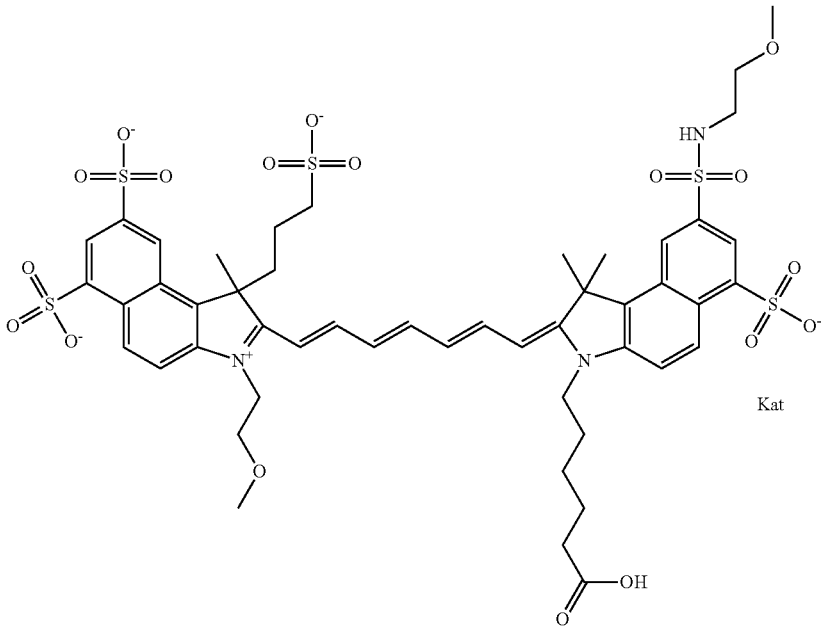
One non-limiting example of an additionally PEG-substituted compound is a 779 Compound 1/2 according to general formula II where R2 is an ethylene glycol group terminating with a methyl group, shown below:



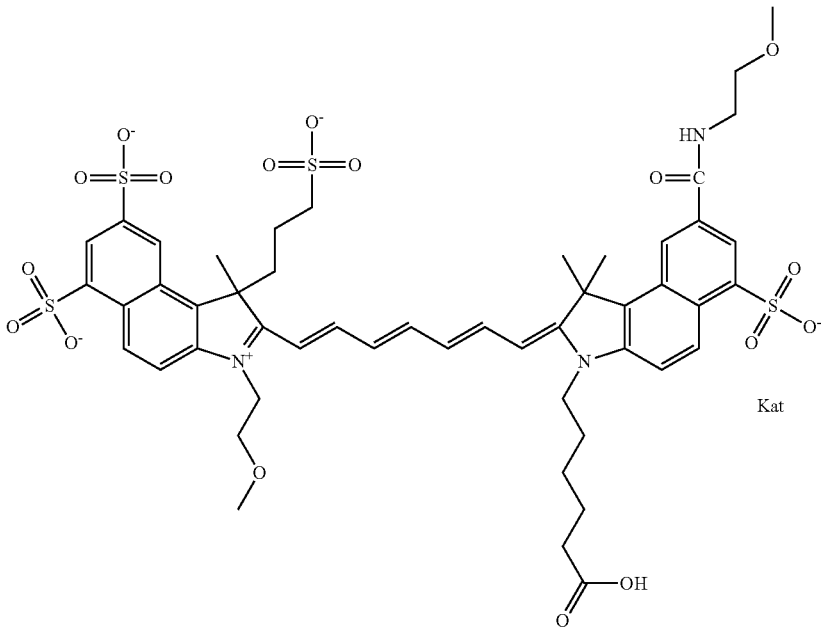
One non-limiting example of an additionally PEG-substituted compound is a 779 Compound 1/2 according to general formula II where R8 is an ethylene glycol group terminating with a methyl group, shown below:



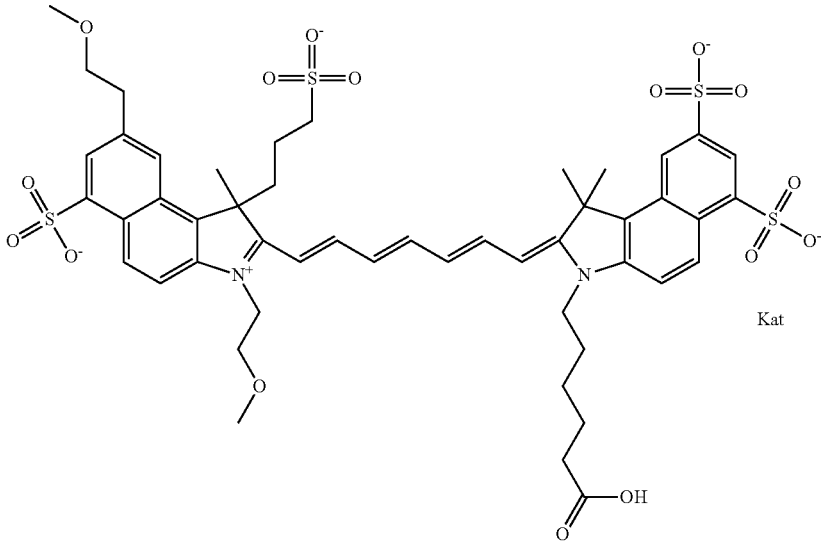
One non-limiting example of an additionally PEG-substituted compound is a 779 Compound 1/2 according to general formula II where R8 is a sulfonamide group with an ethylene glycol group (PEG_1) terminating with a methyl group, shown below:



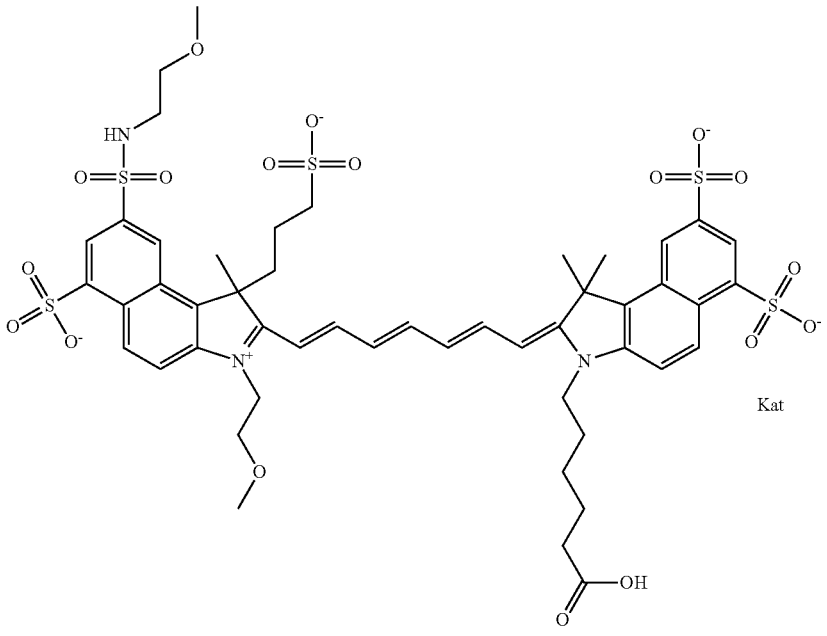
One non-limiting example of an additionally PEG-substituted compound is a 779 Compound 1/2 according to general formula II where R8 is a carboxamide group with an ethylene glycol group (PEG_1) terminating with a methyl group, shown below:



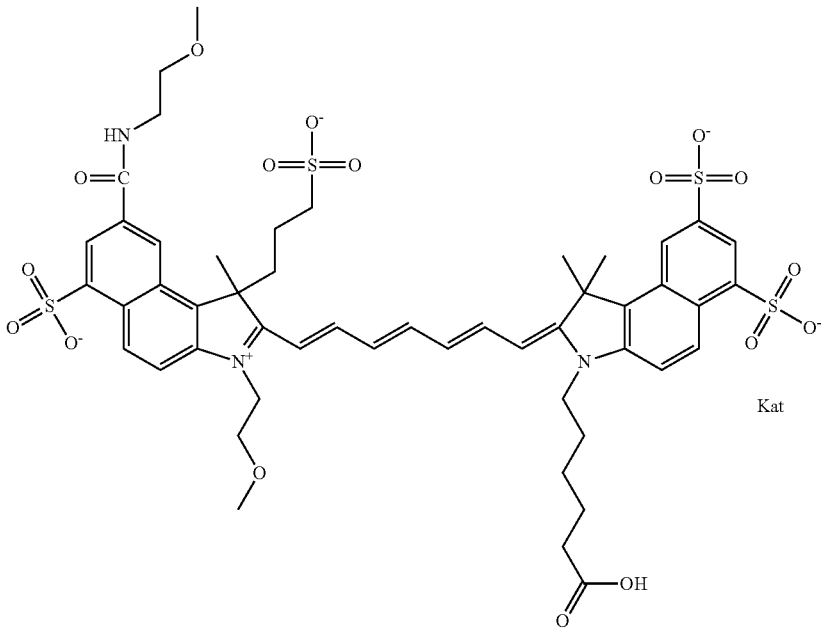
One non-limiting example of an additionally PEG-substituted compound is a 779 Compound 1/2 according to general formula II where R7 is an ethylene glycol group terminating with a methyl group, shown below:



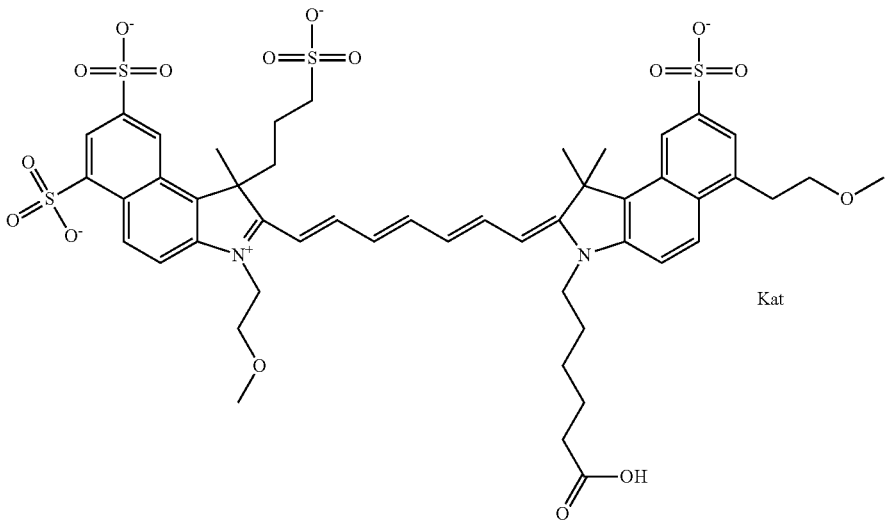
One non-limiting example of an additionally PEG-substituted compound is a 779 Compound 1/2 according to general formula II where R7 is a sulfonamide group with an ethylene glycol group (PEG_1) terminating with a methyl group, shown below:



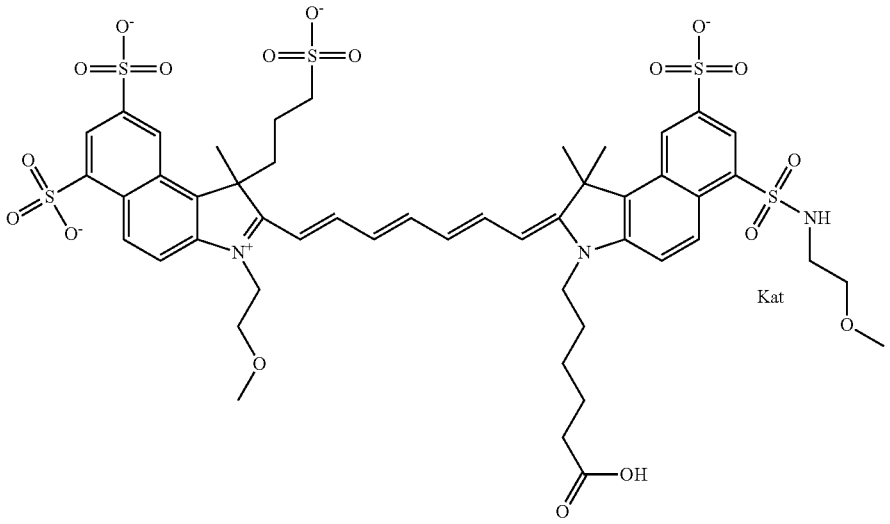
One non-limiting example of an additionally PEG-substituted compound is a 779 Compound 1/2 according to general formula II where R7 is a carboxamide group with an ethylene glycol group (PEG_1) terminating with a methyl group, shown below:



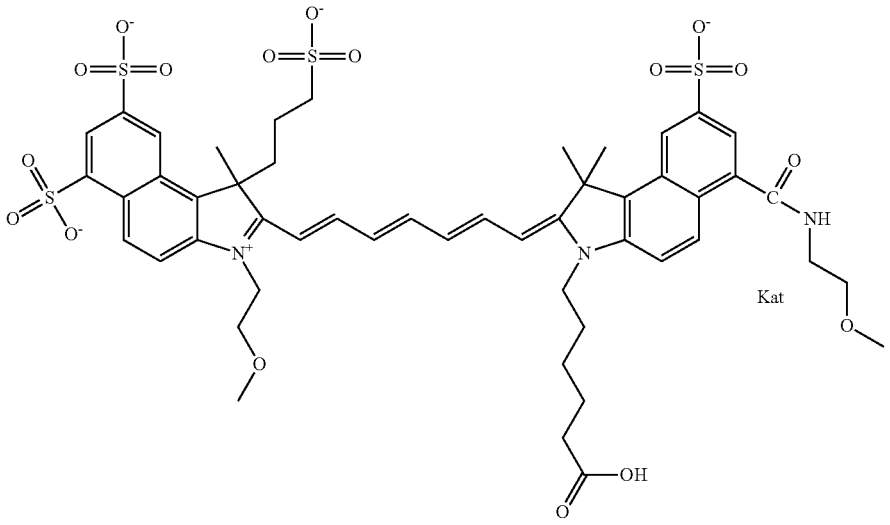
One non-limiting example of an additionally PEG-substituted compound is a 779 Compound 1/2 according to general formula II where R12 is an ethylene glycol group terminating with a methyl group, shown below:



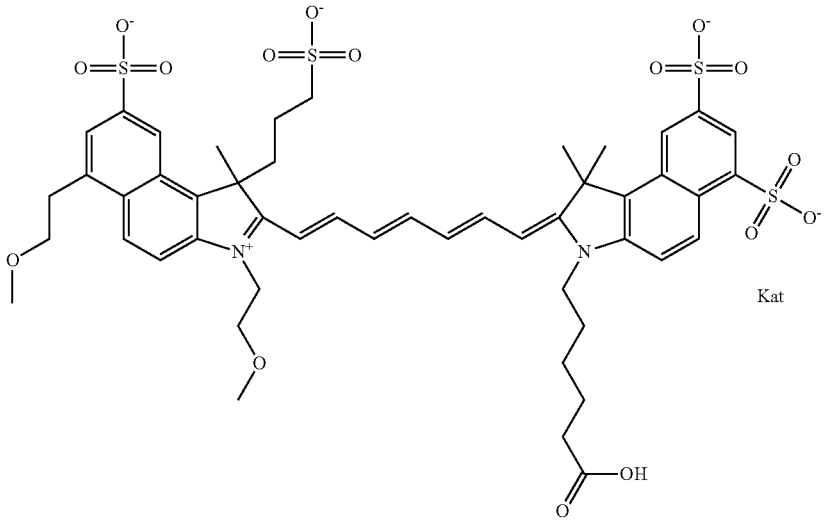
One non-limiting example of an additionally PEG-substituted compound is a 779 Compound 1/2 according to general formula II where R12 is a sulfonamide group with an ethylene glycol group (PEG_1) terminating with a methyl group, shown below:



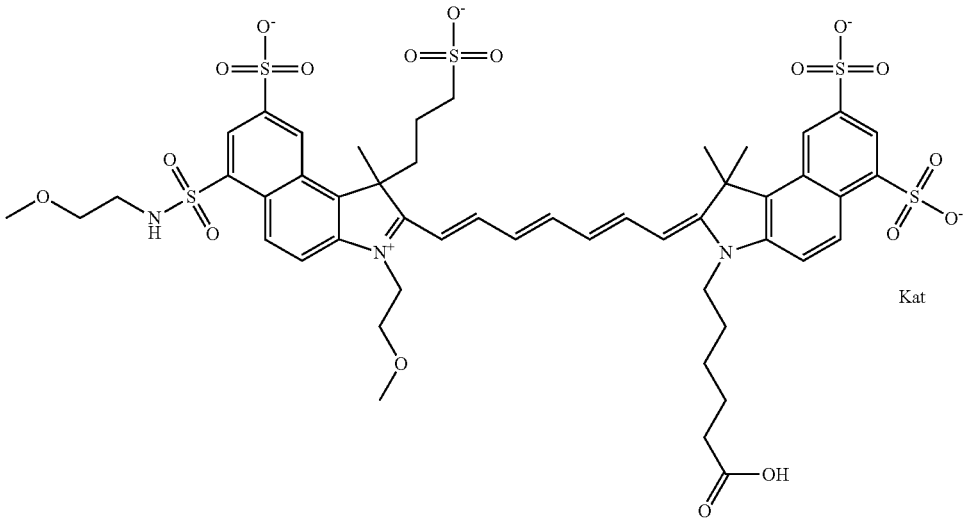
One non-limiting example of an additionally PEG-substituted compound is a 779 Compound 1/2 according to general formula II where R12 is a carboxamide group with an ethylene glycol group (PEG_1) terminating with a methyl group, shown below:



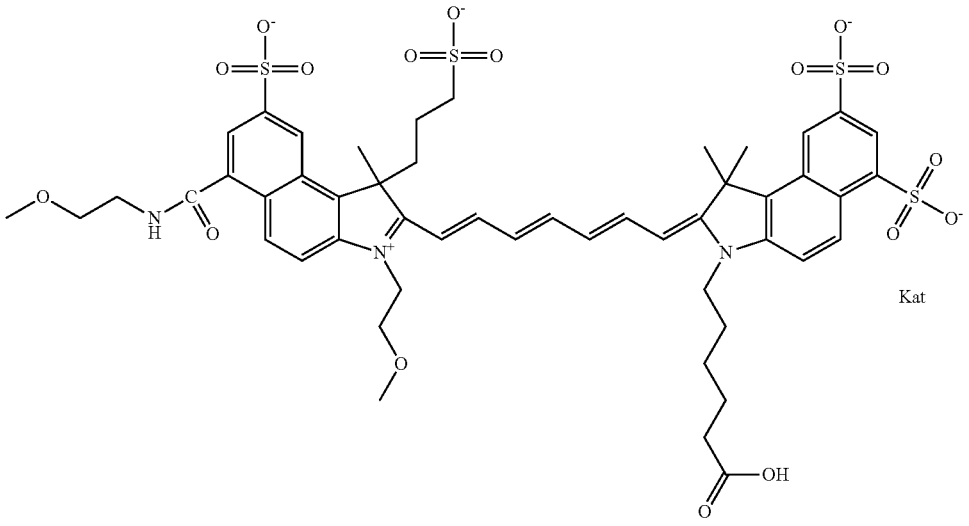
One non-limiting example of an additionally PEG-substituted compound is a 779 Compound 1/2 according to general formula II where R11 is an ethylene glycol group terminating with a methyl group, shown below:



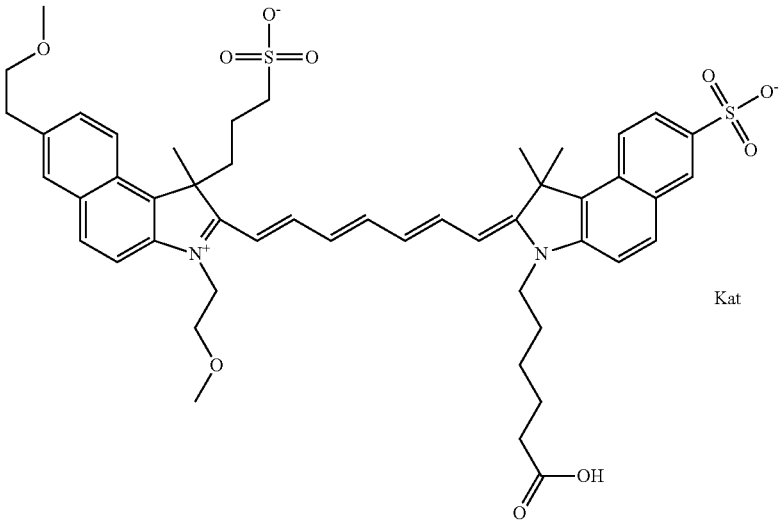
One non-limiting example of an additionally PEG-substituted compound is a 779 Compound 1/2 according to general formula II where R11 is a sulfonamide group with an ethylene glycol group (PEG_1) terminating with a methyl group, shown below:



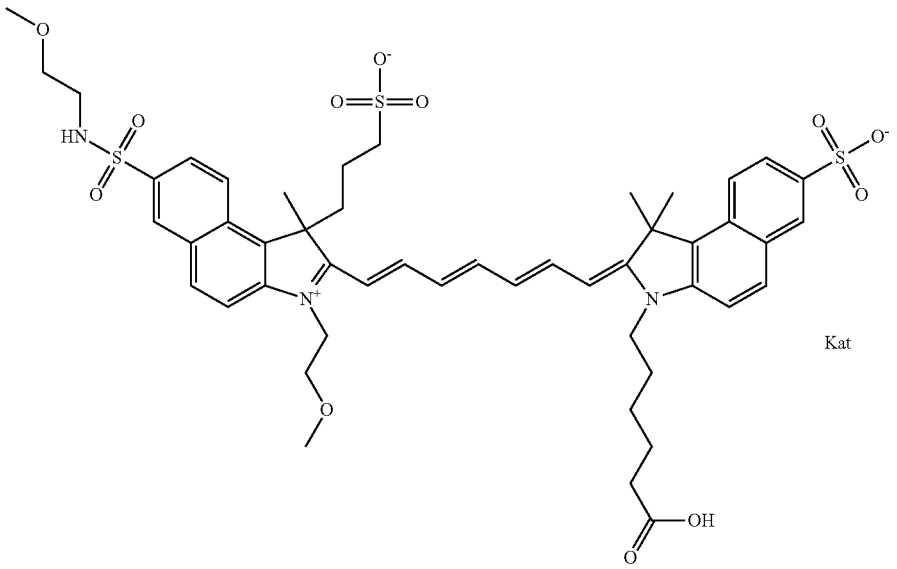
One non-limiting example of an additionally PEG-substituted compound is a 779 Compound 1/2 according to general formula II where R11 is a carboxamide group with an ethylene glycol group (PEG_1) terminating with a methyl group, shown below:



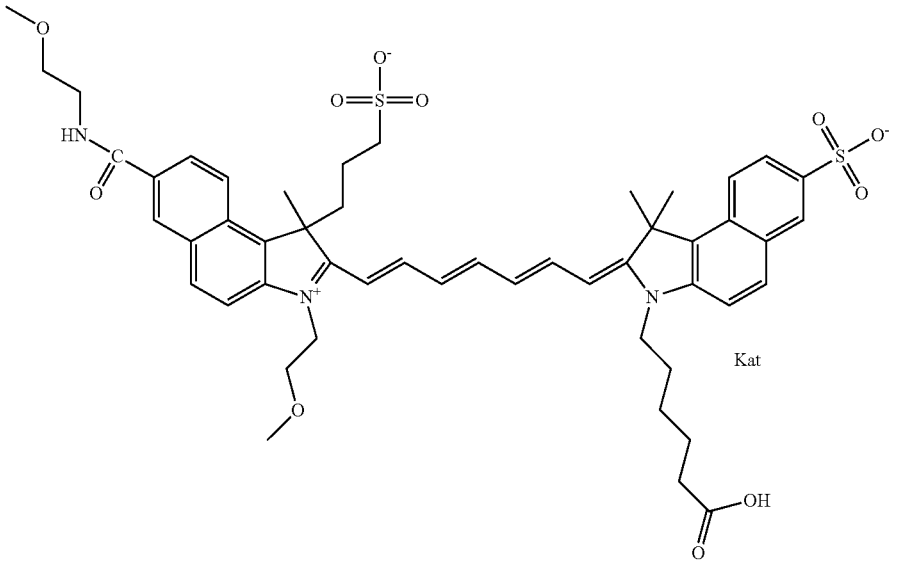
One non-limiting example of an additionally PEG-substituted compound is a 779 Compound 1/2 according to general formula II where R13 is an ethylene glycol group terminating with a methyl group, shown below:



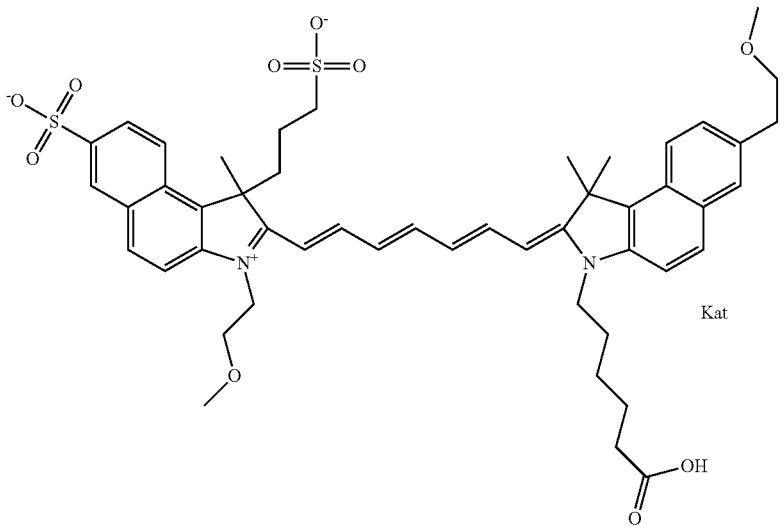
One non-limiting example of an additionally PEG-substituted compound is a 779 Compound 1/2 according to general formula II where R13 is a sulfonamide group with an ethylene glycol group (PEG_1) terminating with a methyl group, shown below:



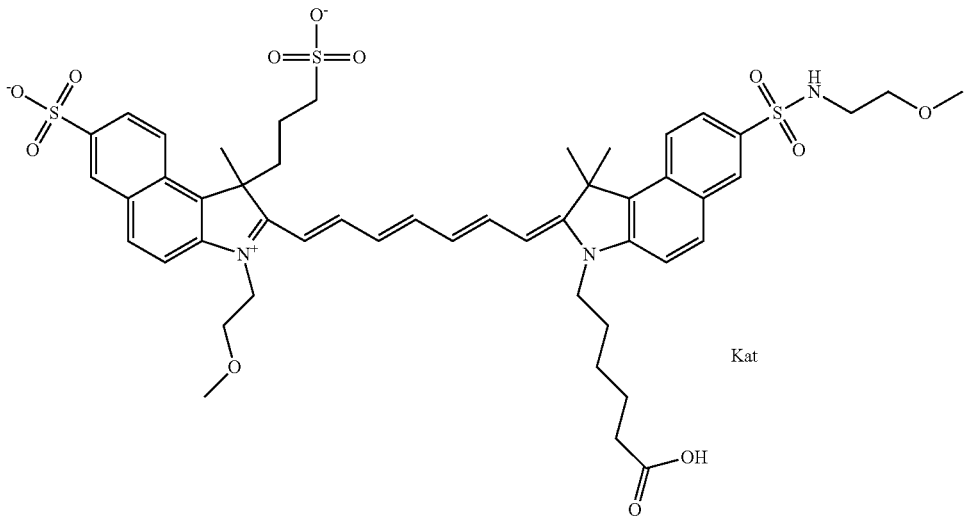
One non-limiting example of an additionally PEG-substituted compound is a 779 Compound 1/2 according to general formula II where R13 is a carboxamide group with an ethylene glycol group (PEG_1) terminating with a methyl group, shown below:



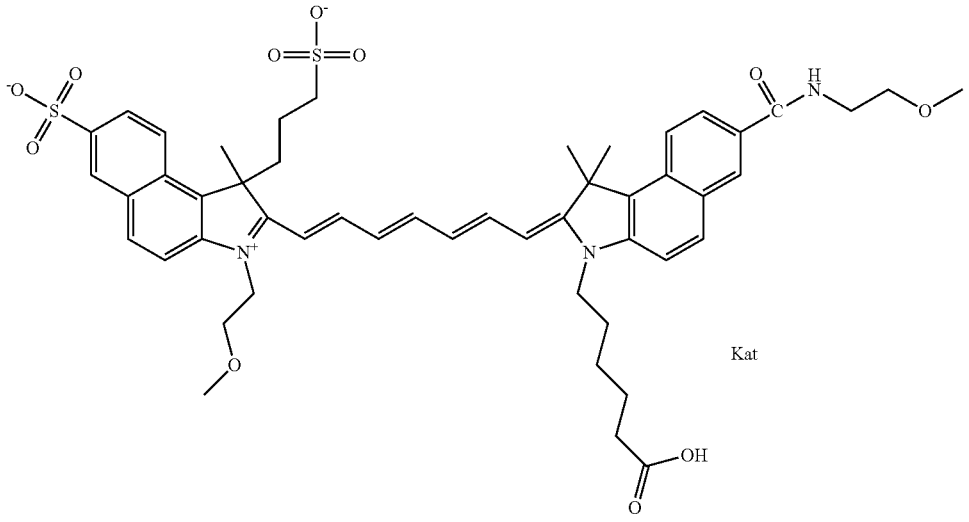
One non-limiting example of an additionally PEG-substituted compound is a 779 Compound 1/2 according to general formula II where R14 is an ethylene glycol group terminating with a methyl group, shown below:



One non-limiting example of an additionally PEG-substituted compound is a 779 Compound 1/2 according to general formula II where R14 is a sulfonamide group with an ethylene glycol group (PEG_1) terminating with a methyl group, shown below:



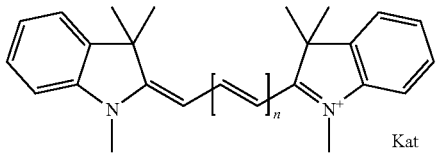
One non-limiting example of an additionally PEG-substituted compound is a 779 Compound 1/2 according to general formula II where R14 is a carboxamide group with an ethylene glycol group (PEG_1) terminating with a methyl group, shown below:



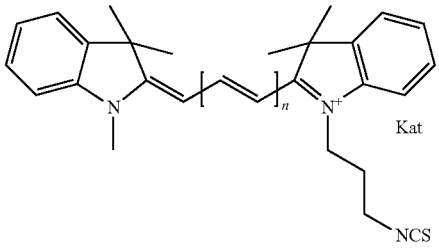
The disclosed compounds are useful as chromophores and/or fluorophores. For example, they are used for optical labelling and, therefore, for the qualitative and/or quantitative detection of proteins, nucleic acids, oligomers, DNA, RNA, biological cells, lipids, mono-, oligo- and polysaccharides, ligands, receptors, polymers, drugs, polymeric beads, etc.

The present compounds, containing the disclosed functionality or functionalities, may be synthesized using methods known in the art, e.g., as described as follows with all references expressly incorporated by reference herein in their entirety.

The core indocyanine structure without additional functionalilities, along with its synthesis, was described by König in U.S. Pat. No. 1,524,791 and BP 434875, and included 3-, 5-, and 7-membered polymethine chains.



Synthesis of numerous modifications of the core indocyanine structure have been described. Such modifications provided various functionalilities, e.g., synthesis of N-isothiocyanatoalkyl- and aromatic-carboxyalkyl-functionalized indocyanines were described in U.S. Pat. Nos. 5,627,027; 6,048,982; 4,981,977; U.S. Publication No. 2006/0199949; Southwick, Anal. Chem. 67 (1995)1742-48).



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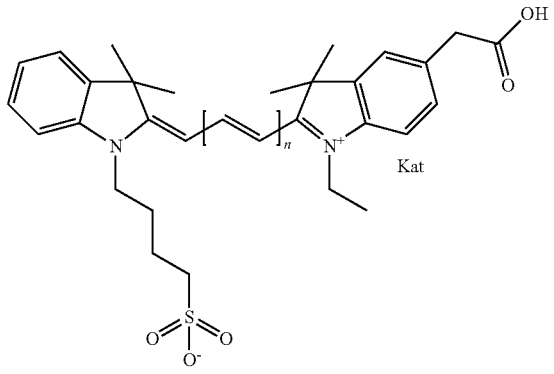
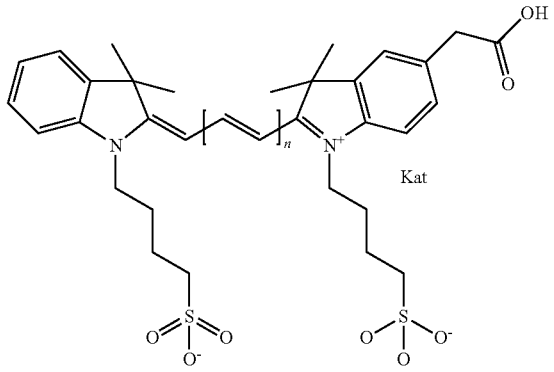
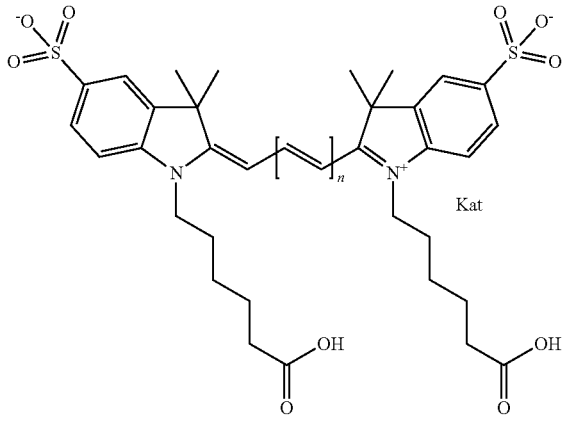




Synthesis of indocyanines with one or two N-carboxyalkyl functionalities were described in U.S. Pat. Nos. 5,268,486; 5,486,616; 5,569,587; 5,569,766; and JP 03217837.



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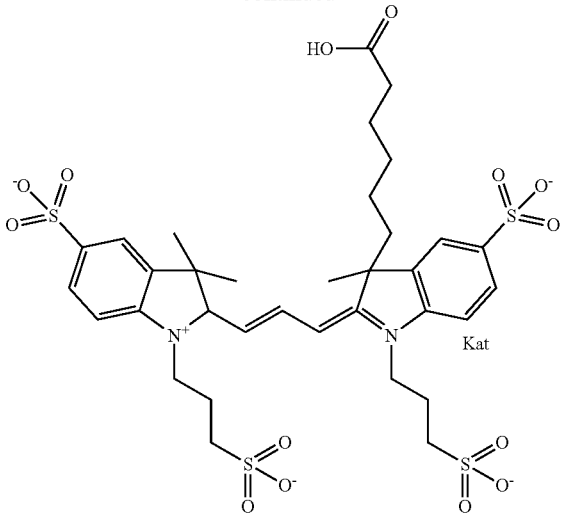
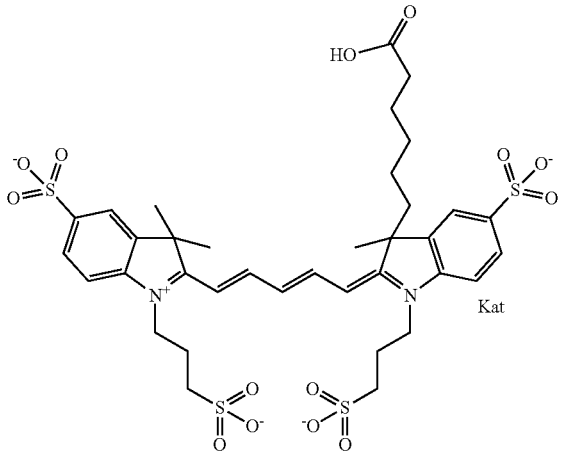
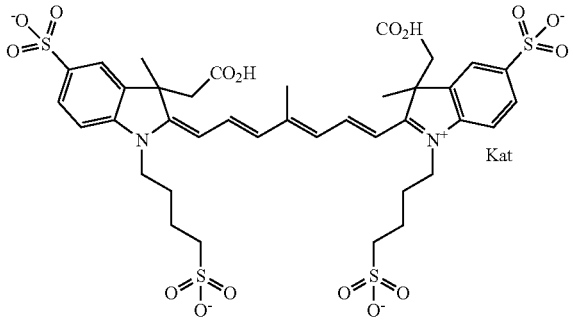
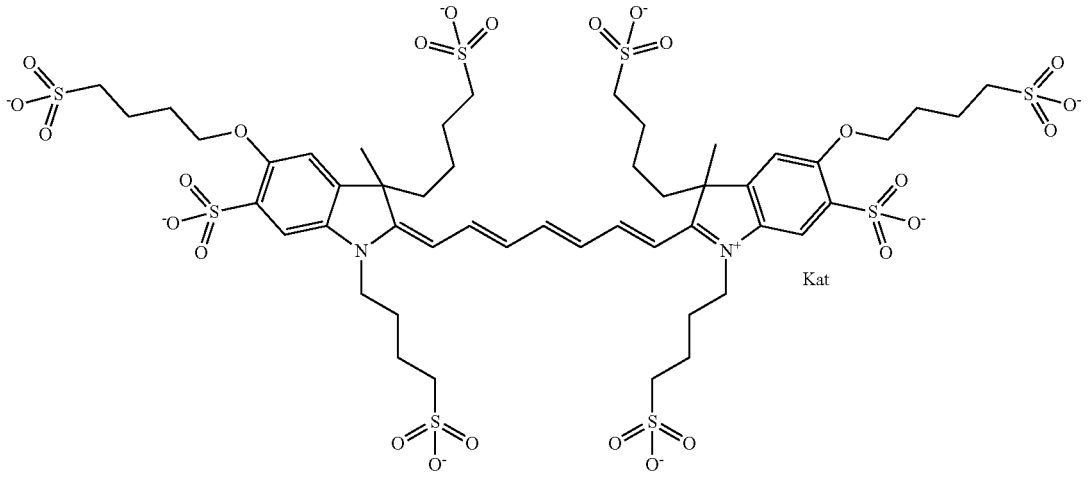


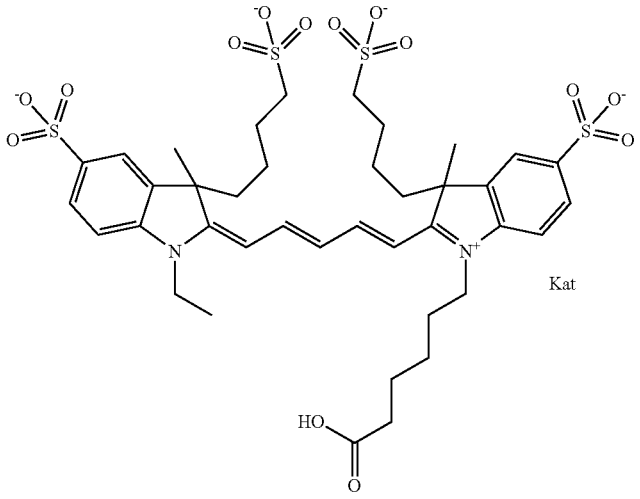
Synthesis of indocyanines containing C-carboxyalkyl groups were described in JP 05-313304; U.S. Publication Nos. 2006/0099638, 2006/0004188; 2002/0077487; 2002/0064794; U.S. Pat. Nos. 6,977,305 and 6,974,873.

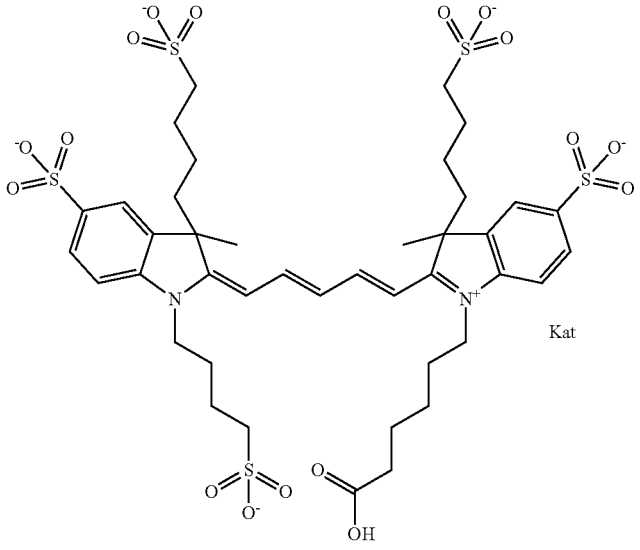




Synthesis of indocyanines with N- and C-sulfoalkyl groups were described in JP 05-313304; WO 2005/044923; U.S. Publication No. 2007/0203343.


Kat


Kat
HO
O


Kat
OH

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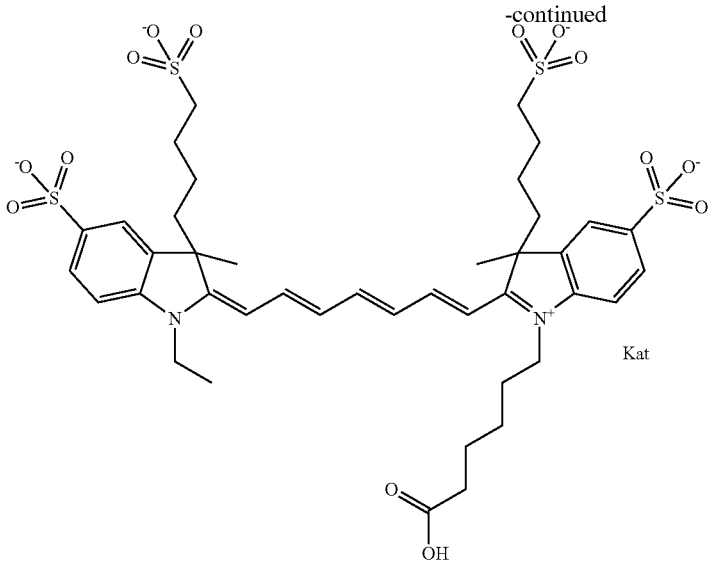

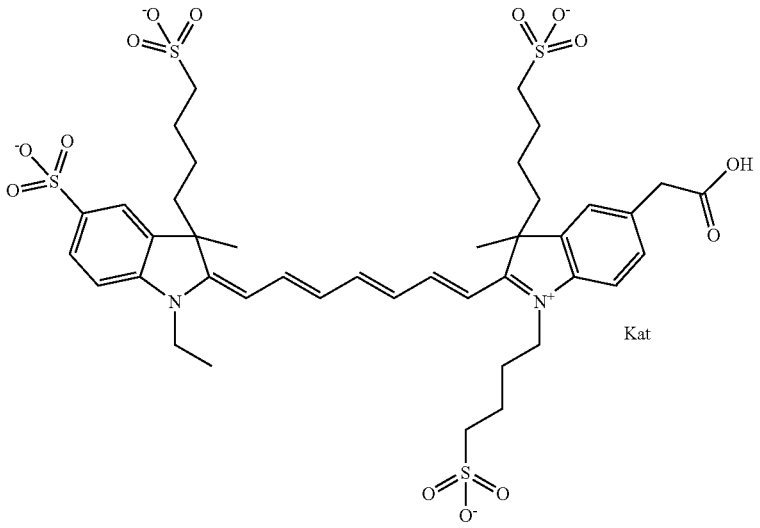

Synthesis of indocyanines with mixed C-carboxyalkyl and C-sulfoalkyl were described in EP 1792949 and U.S. Pat. No. 7,745,640.

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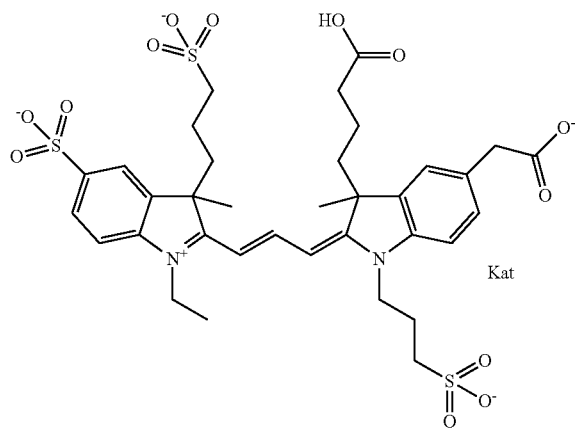

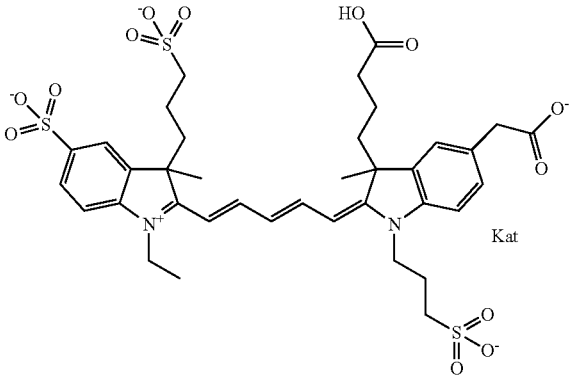

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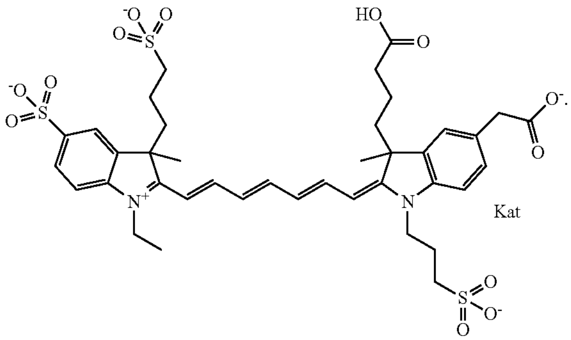
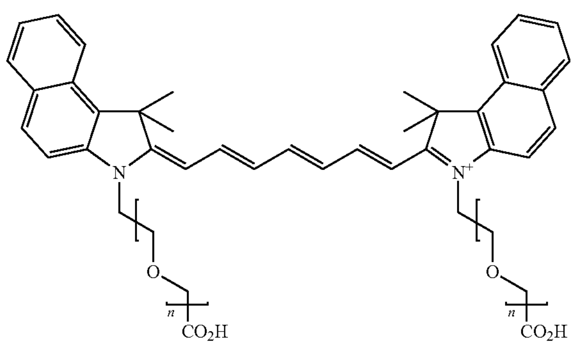
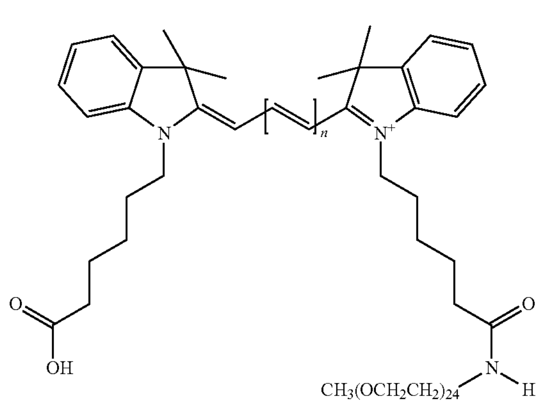


Synthesis of indocyanines having a PEG-containing, N-carboxyalkyl spacer were described in U.S. Pat. No. 6,939,532.



Functionalization of the N-carboxyalkyl with an amino-functionalized PEG-alkyl chain, and N- and C-substituted PEG-alkyl chains, were described in U.S. Publication No. 2009/0305410.



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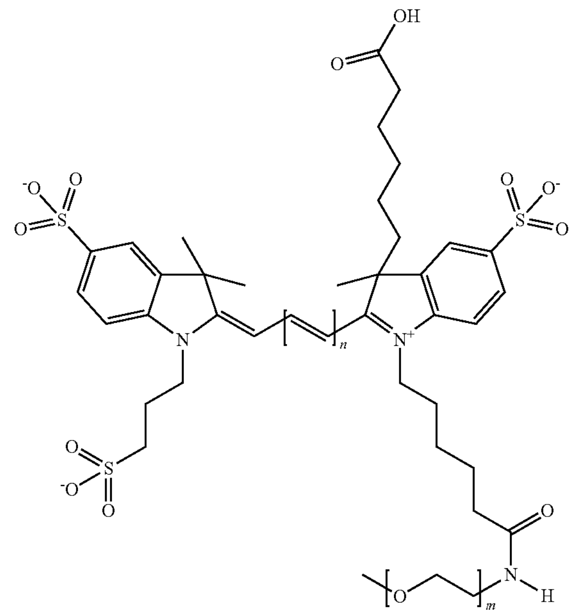

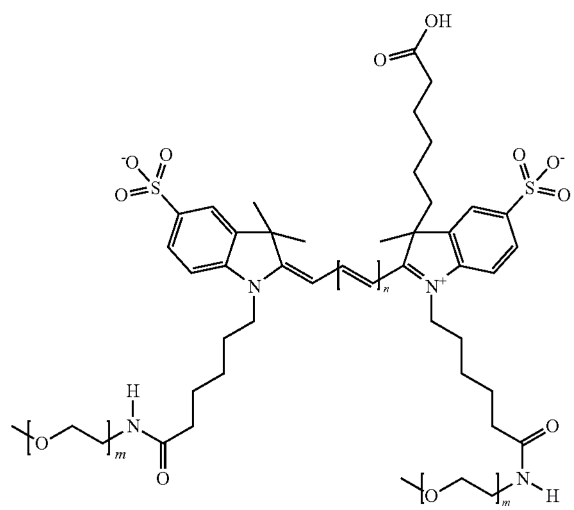

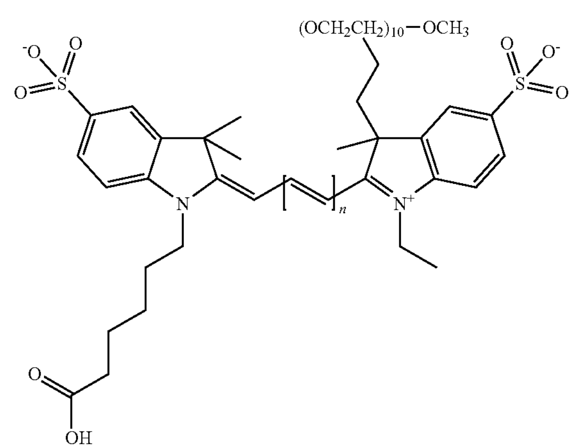

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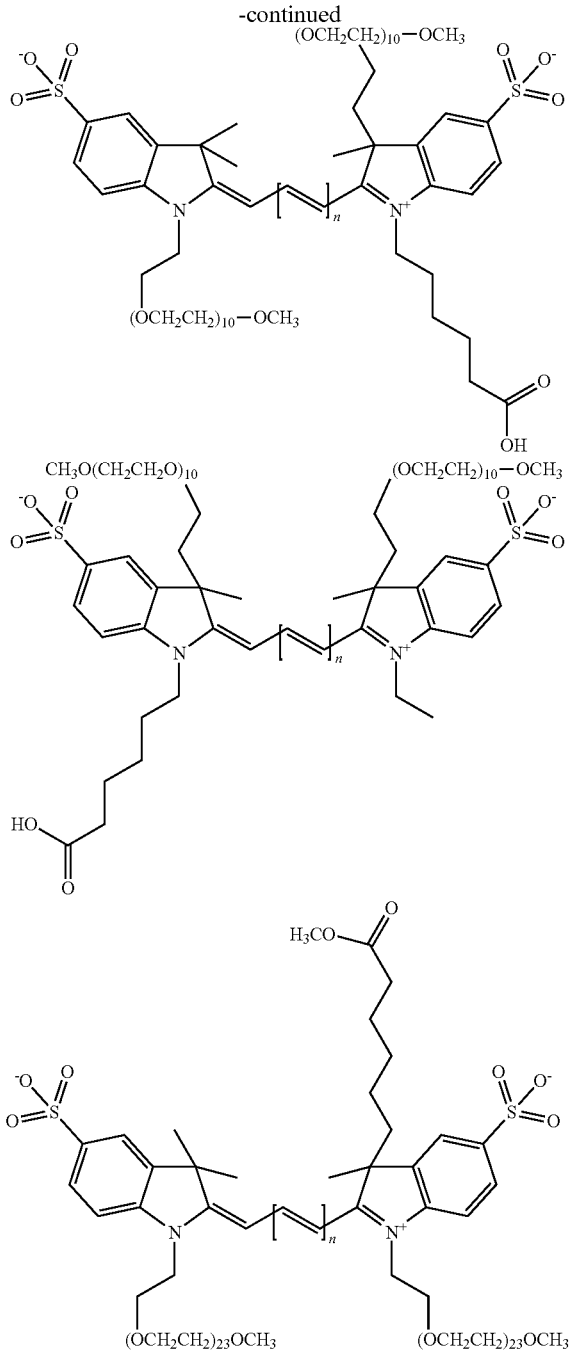


Synthesis of various polymethine bridge substitutions, and other functionalizations of indocyanines, were described in Strekowski, Heterocyclic Polymethine Dyes: Synthesis, Properties and Applications, (2008) Springer-Verlag, Berlin Heidelberg; Gragg, "Synthesis of Near-Infrared Heptamethine Cyanine Dyes" (2010). Chemistry Theses. Paper 28; Patonay et al. (2004) Noncovalent Labeling of Biomolecules with Red and Near-Infrared Dyes. Molecules 9 (2004) 40-49; and U.S. Pat. No. 7,172,907. Examples 1-5 disclose synthesis reactions for the compounds.

In one embodiment, the compound is synthesized by a condensation reaction, known to one skilled in the art, of the two differently substituted indole heterocycles separated by a (poly)methine linker or bridge, e.g., C1, C3, or C5. Other synthesis methods are possible. As only one example, one of the indole heterocycles is first reacted with the C1, C3, or C5 linker. The 1:1 condensation product is isolated, and then condensed with the second indole heterocycle to result in the cyanine compound. The sequence of reacting the indole heterocycles is irrelevant. Thus, a plurality of differently functionalized, strongly hydrophilic, diastereomeric compounds, that differ in total charge and specificity/reactivity of the active groups used for their immobilization, can be easily prepared.

Conjugates of the compounds are prepared by covalently coupling the compounds to a biomolecule using the functional substituent on the N-position of the indole ring. This functional substituent is activated by routine protein chemistry reaction methods known to one skilled in the art. The activated compound may be converted to, without limitation, an N-hydroxysuccinimide (NHS)-ester, an acid fluoride, a tetrafluorophenyl (TFP)- or sulfotetrafluorophenyl (STP)-ester, an iodoacetyl group, a maleimide, a hydrazide, a sulfonyl chloride, a phenylazide. Methods for preparing such compounds are known to one skilled in the art. In one embodiment, the activated substituent is then reacted with an amino group on the biomolecule under conditions to form the linkage. In one embodiment, a non-activated carboxyl group on the N-position of the indole in the compound is coupled to an amine using a carbodimide.

In one embodiment, a N-hydroxysuccinimidyl ester (X=—NHS) of a compound was formed as follows: 20 μmol dye with X=OH (carboxyalkyl group), 8 mg (40 μmol) dicyclohexylcarbodiimide, and 5 mg (40 μmol) N-hydroxysuccinimide were dissolved in 2 ml of DMF and 100 μl water. Six μl (40 μmol) triethylamine was then added. The reaction mixture was stirred at room temperature (about 20° C. to about 22° C.) for 24 hours and then filtered. The solvent was removed and the residue was washed with diethylether. The reaction proceeded quantitatively.

In one embodiment, a maleimide (X=—NH—CH_2CH_2-maleimide) of a compound was formed as follows: 20 μmol dye with X=—NHS (N-hydroxysuccinimid-ester) was dissolved in 2 ml DMF and 100 μl water and mixed with 7.6 mg (30 μmol) 2-maleimidoethylamine-trifluoracetate and 5 μl (30 μmol) N-ethyldiisopropyl-amine. The reaction mixture was stirred for three hours at room temperature (about 20° C. to about 22° C.). The solvent was evaporated under reduced pressure. The residue was washed with diethylether and acetone and dried in vacuum. The reaction proceeded quantitatively.

In one embodiment, a iodoacetamide (X=—NH—CH_2CH_2—NH—CO—CH_2—I) of a compound was formed as follows: 20 μmol dye with X=—NHS (N-hydroxysuccinimid-ester) was dissolved in 2 ml DMF and 100 μl water, followed by the addition of 40 mg (300 μmol) ethylendiamindihydrochloride and 26 μl (150 μmol) N-ethyldiisopropyl-amine. The reaction mixture was stirred for three hours at room temperature (about 20° C. to about 22° C.). The solvent was then evaporated under reduced pressure, the residue was dissolved in methanol, and the ethylendiamindihydrochloride was removed by filtration. The methanol was evaporated under reduced pressure. The residue was dissolved in 2 ml dry DMF, followed by then addition of 7 mg (25 μmol) N-succinimidyl iodoacetate and 4 μl (25 μmol) N-ethyldiisopropyl-amine. The reaction mixture was stirred for three hours at room temperature. The solvent was evaporated under reduced pressure and the residue was purified via reverse phase HPLC.

In one embodiment, a hydroxyl group, such as a terminal hydroxyl group, can be subsequently activated to a reactive

derivative able to link with, for example, proteins and other molecules. Examples of activating groups include tosyl chloride (TsCl), tresyl chloride (TrCl), disuccinimidyl carbonate (DSC), divinyl sulfone, bis-epoxy compounds, carbonyl diimidazole (CDI), 2-fluoro-1-methylpyridinium (FMP), and trichloro-s-triazine (TsT). In one embodiment, the hydroxyl group is activated to a succinimidyl carbonate, which is reactive with amines. For example, disuccinimidyl carbonate (DSC) can be used to create amine-reactive groups from hydroxyls in a single step, as described in Wilchek, M. and Miron, T. (1985) (Activation of Sepharose with N,N'-disuccinimidyl carbonate. Applied Biochemistry and Biotechnology 11, 191-193). DSC reacts with a hydroxyl group, such as at the end of a PEG chain of the described compounds, to directly form a reactive ester with loss of one molecule of NHS. This reactive group, which is an NHS carbonate, can be used to couple a described compound to amine-containing molecules, such as proteins. For example, a reaction of an NHS carbonate with an amine creates a carbamate linkage (a urethane bond), which is as stable as the amide bonds formed from the reaction of an NHS ester with an amine. In one embodiment, a terminal hydroxyl group of a PEG-containing compound can be activated with DSC to provide an NHS carbonate reactive group for coupling to amine-containing molecules. In one embodiment, the group X, as described in the disclosed general formulas, is a spacer arm that terminates in a hydroxyl group, such as a PEG group, which also can be activated with DSC to create the NHS carbonate, i.e., when X=—NR-L-O—CO—NHS.

Coupling between the compound and the biomolecule may be performed as follows. The compound is reacted with the biomolecule in an organic or aqueous solution at a pH between pH 5 and pH 12, inclusive. The compound need not be dissolved in an organic solvent, such as dimethyl formamide (DMF) or dimethyl sulfoxide (DMSO) prior to adding the biomolecule. In one embodiment, coupling reaction may be performed in a 100% aqueous solution. In one embodiment, the coupling reaction occurs at room temperature (about 20° C. to about 22° C.).

To form a dye composition, at least one biocompatible excipient is added to the compound, as known to one of ordinary skill in the art. Excipients include but are not limited to buffers, solubility enhancing agents, stabilizing agents, etc.

In one embodiment, a kit for performing an assay method comprises a disclosed compound, and instructions for performing the method using the compound.

The disclosed activated compounds (i.e., the compound modified with a reactive group) are useful to label macromolecules (e.g., antibodies, streptavidin, etc) using methods known to one skilled in the art, e.g., as disclosed in Hermanson, Bioconjugate Techniques, 2nd Ed., London, Elsevier Inc. 2008. The reaction is carried out for one hour to two hours at room temperature (about 20° C. to about 22° C.), and then desalted by dialyzing against several changes of phosphate buffered saline (pH 7.2) or purified by gel filtration to remove the unreacted fluorescent dye. The resulting compound-biomolecule conjugate is useful in applications such as detection of specific proteins in immunoassays, sugars in glycoproteins with lectins, protein-protein interactions, oligonucleotides in nucleic acid, hybridization, and in electrophoretic mobility shift assays (EMSA).

The resulting compound-biomolecule conjugates exhibit fluorescent properties. They may be used in optical, including fluorescence optical, qualitative and quantitative determination methods. Examples of such methods include, but are not limited to, microscopy, immunoassays, hybridization methods, chromatographic and electrophoretic methods, fluorescence resonance energy transfer (FRET) systems, high throughput screenings, analysis of receptor-ligand interactions on a microarray, etc.

Compounds of any of the embodiments can be used as dyes for optical labelling of organic or inorganic biomolecules, also referred to as recognition units. Recognition units are molecules having specificity and/or affinity for a specific group of molecules. Examples of recognition units include, but are not limited to, antibodies that have affinity for antigens, enzymes that bind and/or react with a specific bond or bonds within a sequence of amino acids in a peptide or react with a substrate, cofactors such as metals that enhance or inhibit specific interactions, lectins that bind specific sugars or sugar sequences (e.g., oligosaccharides, polysaccharides, dextrans, etc.), biotin binding proteins such as avidin and streptavidin that bind biotin and biotinylated molecules, antibody binding proteins such as Protein A, Protein G, Protein A/G and Protein L, sequences of amino acids or metals that have affinity for each other (e.g., histidine sequences bind nickel or copper, phosphate containing proteins that bind gallium, aluminium, etc.), specific sequences of nucleic acids such as DNA and/or RNA oligonucleotides that have affinity for proteins, specific sequences of amino acids that have affinity for DNA and/or RNA, haptens, carotenoids, hormones (e.g., neurohormone), neurotransmitters, growth factors, toxins, biological cells, lipids, receptor binding drugs or organic or inorganic polymeric carrier materials, fluorescent proteins such as phycobilliproteins (e.g., phycoethrin, allophycocyanin), etc. The ionic interactions between these recognition units and the disclosed compounds results in labeling of the recognition units. The recognition unit and compound can be covalently bound. The result is a conjugate for qualitative or quantitative determination of various biomaterials or other organic or inorganic materials using optical methods.

The inventive compounds and/or conjugates are useful in optical, including fluorescence optical, qualitative and/or quantitative determination methods to diagnose properties of cells (molecular imaging), in biosensors (point of care measurements), for investigation of the genome, and in miniaturizing technologies. Microscopy, cytometry, cell sorting, fluorescence correlation spectroscopy (FCS), ultra high throughput screening (uHTS), multicolor fluorescence in situ hybridization (mc-FISH), FRET-systems and microarrays (DNA- and protein chips) are exemplary application fields. As known to one skilled in the art, a microarray, a grid-like arrangement where more than two different molecules are immobilized in a known predefined region on at least one surface, is useful to evaluate receptor ligand interactions. As known to one skilled in the art, a receptor is a naturally occurring or synthetic molecule that exhibits an affinity to a given ligand. Receptors can be used in a pure form or bound to another specie. Receptors can be coupled covalently or noncovalently to a binding partner either directly or indirectly (e.g., through a coupling mediator). Receptor examples include, but are not limited to, agonists and antagonists for cell membrane receptors, toxins and other poisons, viral epitopes, hormone like opiates and steroids, hormone receptors, peptides, enzymes, enzyme substrates, drugs acting as cofactors, lectins, sugars, oligonucleotides, nucleic acids, oligosaccharides, cells, cell fragments, tissue fragments, proteins, antibodies, etc. As known to one skilled in the art, a ligand is a molecule that is recognized by a certain receptor. Ligand examples include, but are not limited to, agonists and antagonists for cell membrane receptors, toxins and other poisons, viral epitopes, hormones like opiates and steroids, hormone receptors, peptides, enzymes, enzyme substrates,

drugs acting as cofactors, lectins, sugars, oligonucleotides, nucleic acids, oligosaccharides, proteins, antibodies, etc.

BRIEF DESCRIPTION OF THE DRAWINGS

The patent or application file contains at least one drawing executed in color. Copies of this patent or patent application publication with color drawing(s) will be provided by the Office upon request and payment of the necessary fee.

FIG. **1** shows absorption/emission profiles of some inventive compounds and commercial dyes.

FIG. **2** graphs functional assay results with some commercial dyes and inventive compounds with one conjugate produced in one embodiment.

FIG. **3** graphs functional assay results with some commercial dyes and inventive compounds with another conjugate produced in one embodiment.

FIG. **4** graphs functional assay results with some commercial dyes and inventive compounds with another conjugate produced in one embodiment.

FIG. **5** graphs functional assay results with some commercial dyes and inventive compounds with one conjugate produced in one embodiment.

FIG. **6** graphs functional assay results with some commercial dyes and inventive compounds with one conjugate produced in one embodiment.

FIG. **7** graphs functional assay results with some commercial dyes and inventive compounds with one conjugate produced in one embodiment.

FIG. **8** shows functional assay results with some commercial dyes and inventive compounds in one embodiment.

FIG. **9** graphs functional assay results with some commercial dyes and inventive compounds in one embodiment.

FIG. **10** graphs functional assay results with some commercial dyes and inventive compounds in one embodiment.

FIG. **11** tabulates functional assay results with some commercial dyes and inventive compounds in one embodiment.

FIG. **12** graphs functional assay results with some some commercial dyes and inventive compounds in one embodiment.

FIG. **13** tabulates functional assay results with some commercial dyes and inventive compounds in one embodiment.

FIG. **14** is a histogram showing functional assay results with some commercial dyes and inventive compounds in one embodiment.

FIGS. **15**A-D show immunofluorescence data with some commercial dyes and inventive compounds forming a conjugate in one embodiment.

FIGS. **16**A-D show immunofluorescence data with some commercial dyes and inventive compounds forming a conjugate in one embodiment.

FIGS. **17**A-D show immunofluorescence data with some commercial dyes and inventive compounds in one embodiment.

FIGS. **18**A-D show immunofluorescence data with some commercial dyes and inventive compounds in one embodiment.

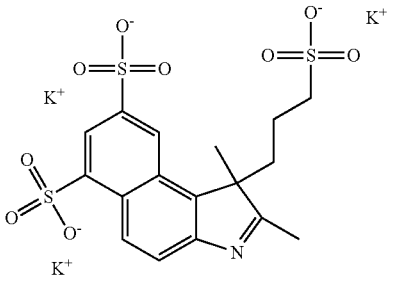
FIGS. **19**A-C show immunofluorescence data with commercial dyes and inventive compounds in one embodiment.

FIGS. **20**A-C show immunofluorescence data with commercial dyes and inventive compounds in one embodiment.

The following non-limiting examples further describe the compounds, methods, compositions, uses, and embodiments. They demonstrate that the inventive compounds exhibited desirable properties relative to commercially available fluorescent dyes. Signal to noise ratio (S/N) is the ratio between the desired signal and the mean of the blank, accounting for the standard deviation of the signal and the blank. Signal to background ratio (S/B) is the ratio between the desired average signal and the average blank.

EXAMPLE 1

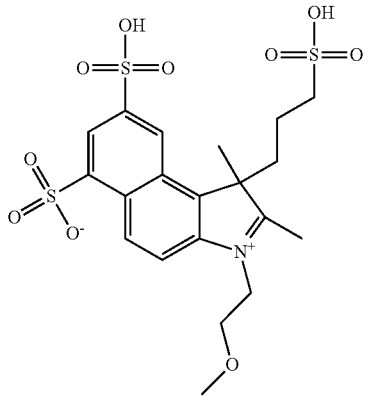
Synthesis of 1,2-Dimethyl-1-(3-sulfopropyl)-1H-benzo[e]indole-6,8-disulfonic acid tri potassium salt



Five g (15.7 mmol) 6-hydrazino-naphthalene-1,3-disulfonic acid and 4.93 g (25 mmol) 4-methyl-5-oxohexane sulfonic acid were dissolved in 50 ml acetic acid. The solution was heated at 140° C. for four hours. The solvent was evaporated in vacuum. The oily residue was dissolved in 20 ml methanol, then 50 ml of a saturated solution of KOH in 2-propanol were added to yield a yellow precipitate. The solid was filtered off and dried in vacuum. Yield 4.1 g, MS (ESI−): 158.2 $[M]^{3-}$

EXAMPLE 2

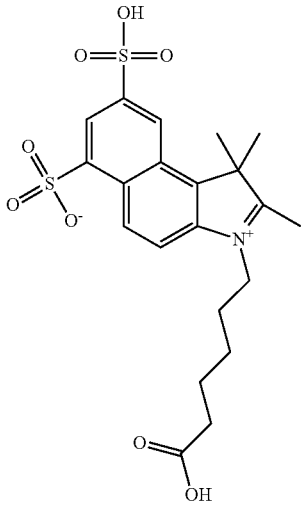
Synthesis of 3-(2-Methoxy-ethyl)-1,2-dimethyl-6,8-disulfo-1-(3-sulfopropyl)-1H-benzo[e]indolium



A mixture of 7.56 g (12.8 mmol) 1,2-dimethyl-1-(3-sulfopropyl)-1H-benzo[e]indole-6,8-disulfonic acid tri potassium salt and 5.89 g (25.6 mmol) 2-methoxyethyl-p-toluene sulfonate was heated under argon for 24 h. The residue was purified by column chromatography (reversed phase silica, methanol/water, TFA). Yield 3.2 g, MS (ESI−): 266.5 $[M-2H]^{2-}$

EXAMPLE 3

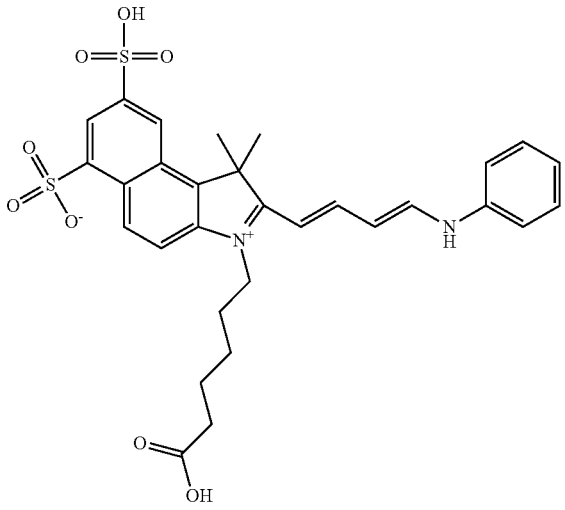
Synthesis of 3-(5-Carboxypentyl)-1,1,2-trimethyl-6,8-disulfo-1H-benzo[e]indolium



A mixture of 5.7 g (12.8 mmol) 1,1,2-trimethyl-1H-benzo[e]indole-6,8-disulfonic acid dipotassium salt and 5 g (25.6 mmol) 6-bromohexanoic acid was heated under argon for 24 h. The residue was purified by column chromatography (reversed phase silica, methanol/water, TFA). Yield 1.4 g, MS (ESI−): 482.1 $[M-H]^-$

EXAMPLE 4

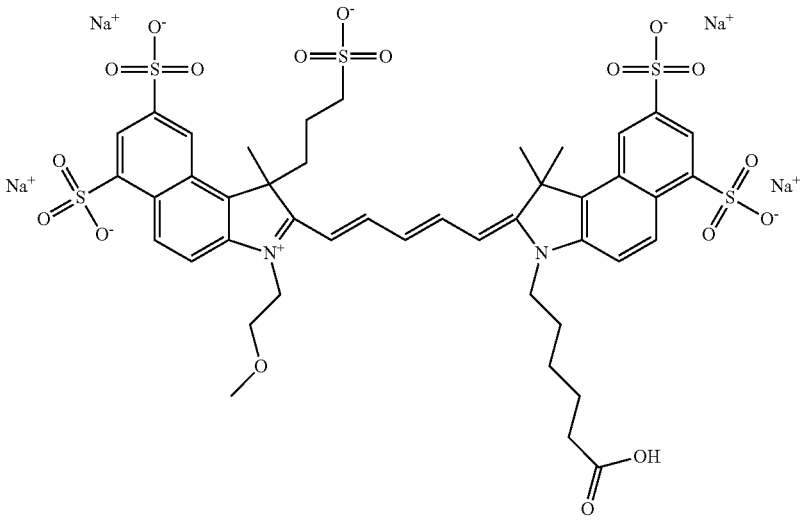
Synthesis of 3-(5-Carboxypentyl)-1,1-dimethyl-2-((1E,3E)-4-phenylamino-buta-1,3-dienyl)-6,8-disulfo-1H-benzo[e]indolium



0.97 g (2 mmol) 3-(5-carboxypentyl)-1,1,2-trimethyl-6,8-disulfo-1H-benzo[e]indolium and 0.57 g (2.2 mmol) malonaldehyde-bisphenylimine-hydrochlorid were dissolved in 10 ml acetic acid and 10 ml acetic anhydride and stirred for four hours at 120° C. The solvent was removed under vacuum. The residue was washed carefully with ethyl acetate. A dark brown solid was obtained which was processed without further purification. MS (ESI−): 611.2 $[M-H]^-$.

EXAMPLE 5

Synthesis of 679 Compound 1/1 (2-{(1E,3E)-5-[3-(5-Carboxypentyl)-1,1-dimethyl-6,8-disulfo-1,3-dihydro-benzo[e]indol-(2E)-ylidene]-penta-1,3-dienyl}-3-(2-methoxy-ethyl)-1-methyl-6,8-disulfo-1-(3-sulfopropyl)-1H-benzo[e]indolium)



612 mg (1 mmol) 3-(5-carboxypentyl)-1,1-dimethyl-2-((1E,3E)-4-phenylamino-buta-1,3-dienyl)-6,8-disulfo-1H-benzo[e]indolium and 533 mg (1 mmol) 3-(2-Methoxy-ethyl)-1,2-dimethyl-6,8-disulfo-1-(3-sulfopropyl)-1H-benzo[e]indolium were dissolved in 20 ml acetic acid/acetic anhydride (1/1) followed by the addition of 200 mg of sodium acetate. The solution was stirred under reflux for 15 min. After cooling to room temperature, 20 ml diethylether was added. The resulting precipitate (mixture of the diastereomers 679 Compound 1/1 (isomer 1) and 679 Compound 1/1 (isomer 2)) was extracted by suction, washed with ether, and dried.

The residue was purified by column chromatography (RP-18, acetonitrile/water and concentrated HCl) to separate the diastereomers from each other. The diastereomer that first eluted from the column was termed diastereomer 1 (679 Compound 1/1 (isomer 1)). The diastereomer that eluted second from the column was termed diastereomer 2 (679 Compound 1/1 (isomer 2)). The diastereomers were separated, followed by neutralization and evaporation. Purification of the single diastereomeric compound was completed on a RP-18 column, acetonitrile/water. The corresponding fractions were pooled and the solvent was removed by distillation. The two products (diastereomers 679 Compound 1/1 (isomer 1) and 679 Compound 1/1 (isomer 2)) were dried in high vacuum.

679 Compound 1/1 (Isomer 1)

yield: 10%

UV-vis (PBS):

λ_{max}=679 nm

λ_{em}=698 nm

MS (ESI−) [M/z]: 262.5 $[M]^{4-}$; 357.7 $[M+Na]^{3-}$

679 Compound 1/1 (Isomer 2)

yield: 23%

UV-vis (PBS):

λ_{max}=679 nm

λ_{em}=698 nm

MS (ESI−) [M/z]: 262.5 $[M]^{4-}$; 357.7 $[M+Na]^{3-}$

EXAMPLE 6

The following properties of 679 Compound 1-NHS were compared with commercially available dyes.

	DyLight 680-NHS	DyLight 680B-NHS	679 Compound 1-NHS	Company B Compound-NHS	Cy5.5 Mono Ester
MW (g/mol)	950	1196.16	1240.21	~1150	1128.42
Ex (nm)	682	679	679	679	675
Em (nm)	715	698	698	702	694
ϵ (M-1cm-1) (theoretical)	140,000	180,000	180,000	184,000	250,000

Emission/excitation profiles for inventive and commercial compounds was determined by reconstituting the compounds in DMF at 10 mg/ml and then diluting in PBS buffer pH 7.2 to 10 μg/ml. Absorbance spectra were collected on Cary UV spectrophotometer and emission spectra were collected on Tecan Safire, shown in FIG. **1** where solid lines represent absorbance spectra and dashed lines represent emission spectra, for DyLight 680-NHS (purple), DyLight 680B-NHS (blue), 679 Compound 1-NHS (red), and Company B Compound-NHS (black). The maximum absorbance and emission for each compound is shown below.

	Max Abs (nm)	Max E nm)
DyLight 680	677	715
DyLight 680B	680	704
679 Compound 1	679	704
Company B Compound	676	706

The following properties of 679 Compound 1-NHS, 679 Compound 4/4-NHS (V08-15173), and 679 Compound 4/4-NHS (V10-04152) were compared with commercially available dyes.

	DyLight 680B-NHS	679 Compound 1-NHS	V08-15173 NHS	V10-04152 NHS	Company B Compound-NHS	Company A Compound-NHS
MW (g/mol)	1196.16	1240.21	1728.8	1524.75	~1150	3241
Ex (nm)	679	679	684	689	679	681
Em (nm)	698	698	706	721	702	698
ϵ ($M^{-1}cm^{-1}$) (theoretical)	180,000	180,000	180,000	180,000	184,000	210,000
PEG (length/# of chain)	0	1/1	4/4	4/4	N/A	?
Sulfonate	5	5	4	2	3	?

EXAMPLE 7

Inventive and commercial compounds, each as the NHS ester, were conjugated to goat anti-mouse (GAM) antibodies, goat anti-rabbit (GAR) antibodies, and streptavidin (SA). GAM, GAR, and SA, at a concentration of 10 mg/ml in phosphate buffered saline (PBS), were dialyzed against 50 mM borate buffer, pH 8.5. The compounds were reconstituted in dimethylformamide (DMF) at 10 mg/ml and combined at

2×, 4×, 5×, 7.5×, or 10× molar excess with GAM, GAR, or SA for two hours at room temperature to label the antibodies or SA.

The labeled compounds, also termed dyes or labels, were subjected to Pierce Dye Removal Resin (PDDR) to remove the unlabeled (free) compound; 100 µl of the packed resin was used per mg of protein purified. The purified antibody-labeled dyes were then diluted 1:50 in PBS and scanned for absorbance from 700 nm to 230 nm to determine the protein concentration, and to determine the mole dye to mole protein ratio. Each conjugate was diluted 1:10 in 50% glycerol and heated in the presence of 10 mM dithiothreitol (DTT) for 5 min at 95° C., then separated by electrophoresis on polyacrylamide gels in the presence of sodium dodecyl sulfate (SDS-PAGE). The gels were scanned using the Typhoon 9400 Imager to verify removal of the unconjugated compound. Labeling efficiency was compared, with results showing degree of labeling below.

	DyLight 680	DyLight 680B	679 Compound 1	Company B Compound	Cy5.5
GAM-2X	0.9	1.9	2.0	—	1.6
GAM-3X	1.3	2.7	3.0	—	2.2
GAM-4X	2.0, 1.9	3.6, 3.6	3.6, 3.7	2.8	2.6
GAM-6X	2.3	5.0	5.1	3.9	—
GAM-8X	2.4	5.6	5.0	4.3	—
GAM-10X	3.0	6.5	6.8	5.4	—
GAM-12X	3.0	7.4	7.2	6.2	—
GAR-1X	0.5	0.9	1.0		0.7
GAR-2X	1.0	1.5	1.6		1.2
GAR-3X	1.3	2.1	2.4		1.7
GAR-4X	1.7, 1.8	2.6, 3.1	3.1, 3.1	2.3	2.2
GAR-6X	2.2	4.4	—	—	—
GAR-8X	2.4	5.5	5.6	4.2	—
GAR-10X	3.5	6.0	6.7	5.3	—
GAR-12X	3.4	6.6	6.7	6.2	—
SA-6X	2.9	4.1	4.0	4.1	—
SA-8X	3.4	4.7	5.0	4.8	—

Labeling efficiency of GAM, GAR and SA was equivalent for 679 compound 1-NHS compared to DyLight 680B-NHS and higher compared to DyLight 680 and Company B compound. The antibodies were labeled, purified, and evaluated by SDS-PAGE as described above. Antibodies were also labeled with Company A compound, which was reconstituted in dimethylsulfoxide (DMSO) and combined at 2×, 5×, 7.5×, 10×, and 15× molar excess with GAM or GAR for sixty-five minutes at room temperature to label the antibodies.

Inventive and commercial compounds, each as the NHS ester, were conjugated to goat anti-rat (GARat) antibodies. GARat, at a concentration of 10 mg/ml in phosphate buffered saline (PBS), was spiked with 10% v/v with 0.67 M borate buffer. The compounds were combined at 5× or 10× molar excess with GAR at for 65 minutes at room temperature to label the antibody. The antibodies were labeled, purified and evaluated by SDS-PAGE as described above.

Labeling efficiency of GARat was slightly higher for 679 Compound 1-NHS compared to DyLight 680B-NHS, V08-15173-NHS and Company B compound-NHS.

In another set of experiments, the labeling of GAM with the inventive and commercial compounds is shown below.

	Mole Dye/Mole Protein Ratio @ 2.5 X	Mole Dye/Mole Protein Ratio @ 5 X	Mole Dye/Mole Protein Ratio @ 7.5 X	Mole Dye/Mole Protein Ratio @ 10 X	Mole Dye/Mole Protein Ratio @ 15 X
V08-15173	2.5	4.9	7.1	8.9	12.4
V10-04152	2.8	5.1	7.4	10.0	13.9
DY679P1	1.8	4.1	6.6	8.5	12.9
Company A compound	1.1	5.3	7.4	9.4	12.6
Company B compound	1.8	4.0	6.3	8.3	13.1

Labeling efficiency of GAM was similar for all the dyes at all molar excesses.

In another set of experiments, the labeling of GAR with the inventive and commercial compounds is shown below, at a molar excess of 5×, 15×, and 25×.

	Mole Dye/ Mole Protein Ratio @ 5 X	Mole Dye/ Mole Protein Ratio @ 15 X	Mole Dye/ Mole Protein Ratio @ 25 X
V08-15173	4.6	12.7	19.6
V10-04152	2.2	10.1	13.9
DY679P1	4.8	10.6	14.4
Company A Compound	3.4	9.8	15.4
Company B Compound	4.1	15.2*	46.7*

At 5×, the labeling efficiency of GAR for all the dyes was similar except for V10-04152. At 15× and 25×, the labeling efficiency was similar except for Company B compound. *Company B compound conjugates precipitated in the Slide-A-Lyzer at molar excesses greater than 10×, indicating this method of purification was not suitable for Company B dyes.

EXAMPLE 8

Performance of the dye-GAM conjugates, dye-GAR conjugates, and dye-SA conjugates was evaluated in a functional assay. Wells of a 96 white opaque plate or black clear-bottom plate were coated with target proteins mouse IgG immunoglobulin, rabbit IgG immunoglobulin, or biotinylated bovine serum albumin (BBSA). One hundred µl mouse or rabbit IgG, or BBSA ata concentration of 10 µg/ml was applied to the corresponding wells in columns 1 and 2. The target proteins were serially diluted 1:1 from the wells in columns 2 to 11 using 100 µl PBS. One hundred µl of the samples from the wells in column 11 were discarded. One hundred µl PBS was added to the wells in column 12. The plates were incubated overnight at 4° C. and then blocked 2×200 µl with Thermo Scientific SuperBlock® Blocking Buffer. The coated plates were washed 2×200 µl with PBS-Tween and 1×200 µl with PBS. Based on the calculated concentrations, conjugates were diluted 1:250 in PBS, added to the corresponding plates (100 µl/well) and then incubated for one hour in the dark. The plates were washed with 2×200 µl with PBS-Tween and 1×200 µl with PBS and filled with PBS buffer (100 µl/well) prior to scanning the white opaque plates on Tecan Safire

using 679 $nm_{excitation}$/702 $nm_{emission}$ or scanning the black clear-bottom plates on LiCor Odyssey at 700 channel, to detect fluorescence intensity.

As shown in FIGS. **2-7**, RFU and/or signal to background ratio (S/B) of the dyes were compared at various concentrations, using the indicated conjugation conditions.

FIG. **2** shows Tecan Safire results of a functional assay using GAM conjugated with either 8× molar excess of the dyes (solid lines) or 10× molar excess of the dyes (dashed lines) of DyLight 680 (purple filled diamond/open square); DyLight 680B (blue filled triangle/X); 679 Compound 1 (red filled circle/asterisk); and Company B Compound (black filled square/+ sign). DyLight 680B-GAM (8×) showed higher binding fluorescence compared to corresponding 679 Compound 1-GAM (8×). At 10× molar excess, 679 Compound 1-GAM showed similar performance to DyLight 680B-GAM. Both DyLight 680 and Company B compound showed much lower intensity compared to DyLight 680B and 679 Compound 1 conjugates. Signal/Background (S/B) was higher for DyLight 680B-GAM conjugates than 679 Compound 1-GAM conjugates. Similar results were generally obtained for GAR conjugates.

FIG. **3** shows Tecan Safire results of a functional assay using SA conjugated with either 6× molar excess of the dyes (solid lines) or 8× molar excess of the dyes (dashed lines) of DyLight 680 (purple filled diamond/open square); DyLight 680B (blue filled triangle/X); 679 Compound 1 (red filled circle/asterisk); and Company B Compound (black filled square/+ sign). 679 Compound 1-SA (6×, 8×) showed slightly lower binding fluorescence compared to corresponding DyLight 680B-SA (6×, 8×). There was no quenching trend with the conjugates at higher molar excesses. The S/B was slightly lower for 679 Compound 1-SA conjugates than for DyLight 680B-SA conjugates.

FIG. **4** shows LiCor Odyssey results of a functional assay using GAM conjugated with either 2× molar excess of the dyes (solid lines) or 4× molar excess of the dyes (dashed lines) of DyLight 680 (purple diamond); DyLight 680B (blue triangle); 679 Compound 1 (red circle); and Cy5.5 (black asterisk). The following table compared S/B and raw intensity data.

	@ 1250 ng coating	@ 39 ng coating	@ 0 (blank)
S/B			
DyLight 680-GAM-2X	25.3	9.8	1.0
DyLight 680-GAM-4X	6.4	2.3	1.0
DyLight 680B-GAM-2X	18.2	4.6	1.0
DyLight 680B-GAM-4X	31.9	8.1	1.0
679 Compound 1-GAM-2X	36.1	7.9	1.0
679 Compound 1-GAM-4X	65.2	15.9	1.0
Cy5.5-GAM-2X	62.3	17.7	1.0
Cy5.5-GAM-4X	19.6	6.1	1.0
Raw Intensity			
DyLight 680-GAM-2X	1941300	751514	76795
DyLight 680-GAM-4X	2596363	937396	403405
DyLight 680B-GAM-2X	5179777	1311798	284501
DyLight 680B-GAM-4X	8614438	2190343	270357
DY679P1-GAM-2X	5180336	1135001	143352
DY679P1-GAM-4X	7482510	1820225	114807
Cy5.5-GAM-2X	3957169	1124788	63513
Cy5.5-GAM-4X	4379901	1358039	223585

FIG. **5** shows LiCor Odyssey results of a functional assay using GAR conjugated with either 2× molar excess of the dyes (solid lines) or 4× molar excess of the dyes (dashed lines) of DyLight 680 (purple diamond); DyLight 680B (blue triangle); 679 Compound 1 (red circle); and Cy5.5 (black asterisk). The following table compared S/B and raw intensity data.

	@ 1250 ng coating	@ 39 ng coating	@ 0 (blank)
S/B			
DyLight 680-GAR-2X	66.7	19.8	1.0
DyLight 680-GAR-4X	62.2	17.4	1.0
DyLight 680B-GAR-2X	210.6	47.5	1.0
DyLight 680B-GAR-4X	167.2	39.3	1.0
DY679P1-GAR-2X	184.0	39.2	1.0
DY679P1-GAR-4X	141.9	33.4	1.0
Cy5.5-GAR-2X	57.3	16.1	1.0
Cy5.5-GAR-4X	26.7	9.0	1.0
Raw Intensity			
DyLight 680-GAR-2X	1868227	554324	28015
DyLight 680-GAR-4X	2140077	597726	34391
DyLight 680B-GAR-2X	4178812	943008	19839
DyLight 680B-GAR-4X	6285439	1476347	37592
DY679P1-GAR-2X	4039443	860737	21950
DY679P1-GAR-4X	6527381	1537020	46001
Cy5.5-GAR-2X	2408459	675886	42049
Cy5.5-GAR-4X	2929556	988970	109613

FIG. **6** shows LiCor Odyssey results of a functional assay using GAM conjugated with either 8× molar excess of the dyes (solid lines) or 10× molar excess of the dyes (dashed lines) of DyLight 680 (purple diamond); DyLight 680B (blue square); 679 Compound 1 (red triangle); and Company B Compound (black X). The following table compared S/B data.

	2500 ng mouse IgG/well	39.1 ng mouse IgG/well
DyLight 680-GAM-8X	173.6	48.9
DyLight 680-GAM-10X	137.2	37.6
DyLight 680B-GAM-8X	929.3	142.4
DyLight 680B-GAM-10X	914.5	165.6
DY679P1-GAM-8X	675.2	110.5
DY679P1-GAM-10X	871.5	183.5
Company B Compound-GAM-8X	459.9	112.4
Company B Compound-GAM-10X	374.0	96.1

679 Compound 1-GAM (10×) showed equivalent bound fluorescence compared to corresponding DyLight 680B-GAM (10×). S/B was lower for 679 Compound 1-GAM (8×, 10×) compared to DyLight 680B-GAM (8×,10×). In general, similar results were obtained for GAR conjugates.

FIG. **7** shows LiCor Odyssey results of a functional assay using SA conjugated with either 6× molar excess of the dyes (solid lines) or 8× molar excess of the dyes (dashed lines) of DyLight 680 (purple diamond); DyLight 680B (blue square); 679 Compound 1 (red triangle); and Company B Compound (black X). The following table compared S/B data.

	250 ng BBSA/well	3.9 ng BBSA/well
DyLight 680-SA-6X	614.5	33.1
DyLight 680-SA-8X	436.3	25.1
DyLight 680B-SA-6X	2196.7	43.8
DyLight 680B-SA-8X	1969.5	75.6
DY679P1-SA-6X	1742.1	58.5
DY679P1-SA-8X	1406.0	54.7
Company B Compound-SA-6X	570.2	49.7
Company B Compound-SA-8X	427.7	36.1

679 Compound 1-SA (6×, 8×) showed lower bound fluorescence and S/B compared to corresponding DyLight 680B-SA (6×, 8×).

679 Compound 1 and Company Compound were conjugated to GAR at high molar excesses, and evaluated in a functional assay, as described above. FIG. **8** shows results expressed as RFU of a functional assay using GAR conjugated with 679 Compound 1 at either a 7.5× molar excess (blue diamond), 15× molar excess (red square), or 22.5× molar excess (green triangle), and Company A Compound at either 7.5× molar excess (purple X), 15× molar excess (turquoise asterisk), or 22.5× molar excess (orange circle).

FIG. **9** shows VarioSkan Flash results with excitation and emission of 679 nm/702 nm, expressed as RFU of a functional assay using GAM conjugated with 5× molar excess of Company B compound (orange diamond), V08-15173 (blue triangle), and V10-04152 (red circle). Based on the data, V08-15173-GAM (5×) showed higher binding fluorescence compared to Company B Compound-GAM (5×).

FIG. **10** shows LiCOR Odyssey results, using the 700 channel, expressed as Raw Fluorescence Intensity of a functional assay using GAM conjugated with 5× molar excess of 679 Compound 1/1 (green triangle), Company A Compound (purple circle), and V08-15173 (blue square). FIG. **11** shows LiCOR Odyssey results expressed as S/B of a functional assay using GAM conjugated at 2.5×, 5×, 10×, or 15× molar excess of 679 Compound 1/1, Company A Compound, and V08-15173. V08-15173-GAM (5×) showed similar binding fluorescence to Company A Compound-GAM (5×). 679 Compound 1/1-GAM (5×) binding fluorescence was lower compared to the other two conjugates.

FIG. **12** shows LiCOR Odyssey results, using the 700 channel, expressed as Raw Fluorescence Intensity of a functional assay using GAR conjugated with 5× and 25× molar excess of 679 Compound 1/1 (green 5×, diamond, solid line; green 25×, diamond, dashed line), Company A Compound (purple 5×, triangle, solid line; purple 25×, triangle, dashed line), V08-15173 (light blue 5×, square, solid line; dark blue 25×, square, dashed line), and V10-04152 (yellow 5×, circle, solid line; red 25×, circle, dashed line). FIG. **13** shows LiCOR Odyssey results expressed as S/B of a functional assay using GAR conjugated at 5×, 15×, or 25× molar excess of 679 Compound 1/1, Company A Compound, V08-15173, and V10-04152. Based on the Raw Fluorescence Intensity data, there was no apparent quenching for the V08-15173-GAR at 25× molar excess. 679 Compound 1/1, V10-04152, and Company A Compound were saturating at 25×. FIG. **14** shows summary Raw Fluorescence Intensity data, and apparent quenching at 1000 ng/well at 25× for 679 Compound 1/1 (679 1), V10-04152, and Company A Compound, but no apparent quenching at 25× for V08-15173.

EXAMPLE 9

The inventive compounds were evaluated for immunofluorescence in cell based assays using the following protocol. Frozen A549 cell plates stored at −20° C. were placed for 30 min 50° C. Storage buffer (PBS) was removed and the cells were permeabilized for 15 min (100 μl/well) with 0.1% Triton-X100 in 1×PBS buffer. Plates were blocked for 30 min in 2% BSA in 1×PBS-0.1% Trion-X100. Primary antibodies diluted in 2% BSA in 1×PBS-0.1% Trion-X100 were added to the plates (column 1-11; column 12 included only blocker) and incubated three hours at room temperature. Mouse anti-lamin A was added at 1 μg/ml and rabbit anti-lamin B1 was added at 3 μg/ml. After overnight incubation, the antibody solution was removed from the plates and the plates were washed with PBS-0.5% Tween-20 (2×100 μl/well). GAM and GAR secondary antibodies labeled with DyLight 680-NHS, DyLight 680B-NHS, 679 Compound 1-NHS and Company B Compound-NHS were diluted to 4 μg/ml in PBS, added and incubated for one hour at room temperature. The plates were then washed three times with 100 μl/well PBS, and Hoechst stain diluted to 0.1 μg/ml in PBS was added to each well (100 μl/well). The plates were scanned on ArrayScan Plate Reader for imaging and quantitation.

FIG. **15** shows results of an immunofluorescence assay using mouse anti-lamin A as a primary antibody, and DyLight 680-GAM (FIG. **15**A), DyLight 680B-GAM (FIG. **15**B), 679 Compound 1-GAM (FIG. **15**C), or Company B Compound-GAM (FIG. **15**D) as secondary antibody, where the compound was conjugated to GAM (secondary antibody) at 4× molar excess (column 1), 6× molar excess (column 2), 8× molar excess (column 3), 10× molar excess (column 4), or 12× molar excess (column 5). 679 Compound 1 conjugated to GAM showed very similar performance to corresponding DyLight 680B conjugates.

The inventive compounds and commercial dye were evaluated for immunofluorescence in a second cell based assay using the following protocol. Frozen U20S cell plates stored at −20° C. were placed overnight at 4° C. Storage buffer (PBS) was removed and the cells were permeabilized for 15 min (100 μl/well) with 0.1% Triton-X100 in 1×PBS buffer. Plates were blocked for 30 min in 2% BSA in 1×PBS-0.1% Trion-X100. Primary antibodies diluted in 2% BSA in 1×PBS-0.1% Trion-X100 were added to the plates (column 1-11; column 12 included only blocker) and incubated five hours at room temperature. Mouse anti-lamin A was added at 2 μg/ml and rabbit anti-lamin B1 was added at 4 μg/ml. After incubation, the antibody solution was removed from the plates and the plates were washed PBS-0.5% Tween-20 (2×100 μl/well). Next, GAM and GAR secondary antibodies labeled with DyLight 680-NHS, DyLight 680B-NHS, 679 Compound 1-NHS, and Cy5.5 Mono Ester were diluted to 4 μg/ml in PBS and incubated with the cells for one hour at room temperature. GAM and GAR conjugated to DyLight 680-NHS, DyLight 680B-NHS, 679 Compound 1-NHS, and Company B Compound at 10× molar excess were diluted to 4 μg/ml in PBS and then serially diluted 1:1 in the plate to the following concentrations: 2 μg/ml, 1 μg/ml, 0.5 μg/ml, 0.25 μg/ml, 0.125 μg/ml and/or 0.0625 μg/ml. The plates were washed 3× with 100 μl/well PBS, and Hoechst stain diluted to 0.1 μg/ml in PBS was added to each well (100 μl/well). The plates were scanned on ArrayScan Plate Reader for imaging and quantitation.

FIG. **16** shows results of an immunofluorescence assay using mouse anti-lamin A as a primary antibody, and either DyLight 680-GAM (FIG. **16**A), DyLight 680B-GAM (FIG. **16**B), 679 Compound 1-GAM (FIG. **16**C), or Cy5.5-GAM (FIG. **16**D) as secondary antibody, where the compound was conjugated to GAM (secondary antibody) at 2× molar excess (column 1), 3× molar excess (column 2), or 4× molar excess (column 3). Performance in immunofluorescence of 679 Compound 1 conjugate was similar to the performance of corresponding DyLight 680B conjugates. Quantitative analysis of FIG. **16** data, expressed as Mean Total Intensity, which is the average total intensity of all pixels within a defined area or defined primary object such as a nucleus, is shown below.

	Mean Total Intensity		
	2X	3X	4X
DyLight 680	91899	122829	144792
DyLight 680B	150542	228678	305700
DY679P1	232482	263580	330865
Cy5.5	211945	342208	451111

Fluorescence signal intensity for DyLight 680B and 679 Compound 1 GAM conjugates was 2-4 times higher, depending on the molar excess, compared to DyLight 680 or Cy5.5 GAM conjugates, and S/B for DyLight 680B & 679 Compound 1 GAM conjugates at the low molar excesses was comparable to each other and to DyLight 680. Overall fluorescence signal intensity for DyLight 680B and 679 Compound 1 GAR conjugates was about two times higher compared to DyLight 680. The S/B for DyLight 680B and 679 Compound 1 GAR labeled at 2×, 3× or 4× molar excess were comparable to each other and to DyLight 680 conjugates.

In the indicated experiments, the inventive compounds were evaluated for immunofluorescence in cell based assays using the following protocol. Frozen A549 cell plates stored at −20° C. were placed for 30 min 50° C. Storage buffer (PBS) was removed and the cells were permeabilized for 15 min (100 μl/well) with 0.1% Triton-X100 in 1×PBS buffer. Plates were blocked for 30 min in 2% BSA in 1×PBS-0.1% Trion-X100. Primary antibodies diluted in 2% BSA in 1×PBS-0.1% Trion-X100 were added to the plates (column 1-11; column 12 included only blocker) and incubated three hours at room temperature. Mouse anti-lamin A was added at 1 μg/ml and rabbit anti-lamin B1 was added at 3 μg/ml. After overnight incubation, the antibody solution was removed from the plates and the plates were washed with PBS-0.5% Tween-20 (2×100 μl/well). GAM and GAR secondary antibodies labeled with DyLight 680-NHS, DyLight 680B-NHS, 679 Compound 1-NHS and Company B Compound-NHS were diluted to 4 μg/ml in PBS, added and incubated for one hour at room temperature. The plates were then washed three times with 100 μl/well PBS, and Hoechst stain diluted to 0.1 μg/ml in PBS was added to each well (100 μl/well). The plates were scanned on ArrayScan Plate Reader for imaging and quantitation.

In the indicated experiments, the inventive compounds and commercial dye were evaluated for immunofluorescence in a cell based assay using the following protocol. Frozen U20S cell plates which were stored at −80° C. were thawed for 45 minutes at 50° C. Storage buffer (PBS) was removed and the cells were permeabilized for 15 minutes with 0.1% Triton-X100 in 1×PBS buffer (100 μl/well). The cell plate was blocked for 60 minutes in 2% BSA/PBS-0.1% Triton-X100. Primary antibody, either rat anti-Grp94 (5 μg/ml), mouse anti-lamin A (10 μg/ml), or rabbit anti-lamin B1 (10 μg/ml), diluted in 2% BSA/PBS-0.1% Triton-X100 was added to the plate and incubated for 1 hour at room temperature. Control wells contained only 2% BSA/PBS-0.1% Triton-X100 blocker. After incubation, the antibody solution was removed from the plate and the plate was washed three times with 100 μl/well of PBS-0.5% Tween-20 and one time with 100 μl/well PBS. GARat, GAM, or GAR secondary antibodies labeled with various molar excess of the inventive or commercial compound were diluted to 4 μg/ml in PBS and incubated for 1 hour at room temperature. The plates were washed three times with 100 μl/well of PBST and once with 100 μl/well PBS, and Hoechst (diluted to 0.1 μg/ml in PBS) was added to each well (100 μl/well). The plates were scanned on ArrayScan Plate Reader or ToxInsight Instrument.

FIG. **17** shows detection of Grp94 in U2OS cells (column 1) with 679 Compound 1-GARat (FIG. **17**A), DyLight 680B-GARat (FIG. **17**B), V08-15173-GARat (FIG. **17**C), and Company B Compound-GARat (FIG. **17**D) conjugated at a 5× molar excess; and associated controls (column 2).

FIG. **18** shows detection of Grp94 in U20S cells (column 1) with 679 Compound 1-GARat (FIG. **18**A), DyLight 680B-GARat (FIG. **18**B), V08-15173-GARat (FIG. **18**C), and Company B Compound-GARat (FIG. **18**D) conjugated at a 10× molar excess; and associated controls (column 2).

As shown in FIGS. **17-18**, no non-specific binding was observed with V08-15173-GARat and Compound B Compound-GARat conjugates but there was with DY679P1 and DyLight 680B-GARat conjugates.

Quantitative analysis of the data of FIGS. **17-18**, expressed as Mean Total Intensity, which is the average total intensity of all pixels within a defined area or defined primary object such as a nucleus, is shown below.

	Negative Controls					
	5X	10X	5X	10X	S/B (5X)	S/B (10X)
679 Compound 1-GARat	81221	97162	36744	70585	2.2	1.4
DyLight 680B-GARat	77855	91720	34773	61355	2.2	1.5
V08-15173-GARat	76825	70881	28190	26341	2.7	2.7
Company B Compound-GARat	64881	56119	26762	30379	2.4	1.8

S/B was slightly better for V08-15173-GARat conjugates (5×, 10×) compared to the corresponding 679 Compound 1-GARat, DyLight 680B-GARat, and Company B Compound-GARat conjugates.

679 Compound 1-GAM, Company A Compound-GAM, and Company A Compound R-GAM were evaluated for immunofluorescence in a cell based assay using detection of PDI in cells with a mouse anti-PDI antibody. FIG. **19** shows results of 679 Compound 1-GAM at a 15× molar excess (FIG. **19**A), Company A Compound-GAM at a 15× molar excess (FIG. **19**B), and Company A Compound R-GAM at a 15× molar excess (FIG. **19**C). As FIG. **19** shows, 679 Compound 1-GAM exhibited proper staining of PDI in the ER while Company A Compound-GAM and Company A Compound R-GAM exhibited non-specific staining with staining found throughout the cell. Similar results were obtained for 679 Compound 1-GAM at 7.5× and 22.5× molar excesses, as well as Company A Compound-GAM and Company A Compound R-GAM at 7.5× molar excess (data not shown).

FIG. **20**A-C shows detection of lamin A in U20S cells (column 1) with V08-15173-GAM, V10-04152-GAM, 679 Compound 1/1-GAM, Company A Compound-GAM, and Company B Compound-GAM conjugates (4 μg/ml) at 5× molar excess (FIG. **20**A), 10× molar excess (FIG. **20**B), and 15× molar excess (FIG. **20**C) with V08-15173-GAM (row A FIGS. **20**A, **20**B, **20**C), V10-04152-GAM (row B FIGS. **20**A, **20**B, **20**C), 679 Compound 1/1-GAM (row C FIGS. **20**A, **20**B, and **20**C), Company A Compound-GAM (row D FIGS. **20**A, **20**B, **20**C), Company B Compound-GAM (row E FIGS. **20**A, **20**B, **20**C), and associated negative controls (column 2). There was very little non-specific binding observed with V08-15173-GAM and 679 Compound 1/1-GAM. Company A Compound-GAM and Company B Compound-GAM conjugates showed high non-specific binding starting from 5× molar excess. At low molar excess, Company A Compound-

GAM exhibited staining of the nucleus, which was greater than the other dyes. V10-04152-GAM exhibited good specificity but was not very bright. Staining of the nucleus with Company B Compound-GAM was greatly improved at 15× molar excess, but there was an increase in non-specific binding.

The following table shows quantitative analysis of the FIGS. **20**A-C data expressed as Mean Total Intensity, which is the average total intensity of all pixels within a defined area or defined primary object such as a nucleus, and S/B ratios.

	V08-15173		V10-04152		679 Compound 1/1		Company A Compound		Company B Compound	
Average		Negative control		Negative control		Negative control		Negative control		Negative control
2.5 X	17366	5966	11946	6085	29229	5628	54496	9107	7092	6329
5.0 X	32820	6643	12788	7357	49279	5859	72289	20303	11922	8360
7.5 X	42876	7100	12513	6503	28782		152502	51104	18894	13351
10 X	47756	9690	21147	6266	30098	6115	188505	136044	25020	18330
15 X	49060	10779	15942	6746	48071	7277	679693	665370	67705	24350

S/B	V08-15173	V10-04152	679 Compound 1/1P1	Company A Compound	Company B Compound
2.5 X	2.9	2.0	5.2	6.0	1.1
5.0 X	4.9	1.7	8.4	3.6	1.4
7.5 X	6.0	1.9	4.9	3.0	1.4
10 X	4.9	3.4	4.9	1.4	1.4
15 X	4.6	2.4	6.6	1.0	2.8

Lamin A, a nuclear protein, should show staining specific to the nucleus. Any lamin A staining outside the nucleus is non-specific staining. In addition, negative control conditions that lack a primary antibody are also used to determine the antibody staining specificity. Company A and Company B Compounds showed no non-specific binding. V08-15173 and 679 Compound 1/1 exhibited a minimal amount of non-specific binding. Due to the strong non-specific binding at higher molar excesses, Company A and Company B Compounds exhibited decreased signal to background (S/B) levels.

Quantitative analysis of a repeat experiment of FIG. **20**A-C are shown below.

	V08-15173		Company A Compound		679 Compound 1/1	
Average		Negative control		Negative control		Negative control
2.5 X	118440	12053	198471	24758	77195	8711
5 X	183078	9441	351666	84270	140772	8674
10 X	391473	13094	638569	330337	159948	20481
15 X	211270	17260	560119	632936	199626	16277

S/B	V08-15173	Company A Compound	679 Compound 1/1
2.5 X	9.8	8.0	8.9
5 X	19.4	4.2	16.2
10 X	29.9	1.9	7.8
15 X	12.2	0.9	12.3

Company A Compound showed much higher non-specific binding compared to V08-15173 and 679 Compound 1/1, with the non specific binding appearing at the 2.5× condition for Company A Compound-GAM.

679 Compound 1/1-NHS and V08-15173-NHS showed on average a 20% lower intensity compared to Company A Compound-NHS. V10-04152 intensity was about 50% lower than V08-15173, and about 65% lower than Company A Compound. GAM labeling efficiency was similar for all dyes at all molar excesses. At 5× molar excess, the GAR labeling efficiency for all dyes was similar, except for V10-04152. At 15× and 25× molar excesses, the GAR labeling efficiency similar for all compounds except Company B Compound. In immunofluorescence studies, Company A Compound, 679 Compound 1/1, and Company B Compound GAM conjugates showed high non-specific binding. V08-15173 and V10-04152 GAM conjugates showed little non-specific binding. Performance of conjugates in immunofluorescence appeared to be highly dependent on the performance of the primary antibody.

EXAMPLE 10

The inventive compounds are used for in vivo imaging to obtain information about biological tissues that are primarily accessible. The compounds are responsive to light in the near infrared region of the spectrum, a part of the spectrum that has minimal interference from the absorbance of biological materials. In one embodiment, the compounds are used for fluorescent imaging of targets within animals. For example, in vivo imaging information can be obtained using methods such as X-ray, magnetic resonance imaging, positron emission tomography, ultrasound imaging and probing, and other non-invasive methods used for diagnosing and treating disease. Light in the near infrared range (NIR), from about 650 nm to about 1000 nm wavelength, can permeate through

several centimeters of tissue and thus can be used for in vivo imaging. Fluorescent dyes, such as the inventive compounds that are responsive to light in these longer wavelengths, can be used as conjugates with targeting molecules such as antibodies to bind and accumulate in, e.g., diseased tissue such as tumors, and may be used to distinguish healthy from diseased tissue. In some methods, the inventive compound may be attached to a biomolecule, such as a protein, peptide, or a drug, which is localized or retained in the desired tissue environment. Fluorescent in vivo imaging using NIR dyes such as the inventive compounds are diagnostic agents to discretely target disease tissue directly within animals or humans.

For in-vivo imaging, the compound, an isomer of the compound, or a conjugate of the compound or isomer with a targeting agent, is administered to a tissue (e.g., intravenously), permitted to accumulate with excess compound removed by the circulatory system, then the tissue is irradiated with light at an appropriate wavelength. The NIR fluorescent light is recorded and/or an image is generated from the data obtained to specifically detect and visualize the targeted cells or tissues. The dose of compound administered can differ and would be known by one skilled in the art depending upon the specific tissue, application, etc., as long as the method achieves a detectable concentration of the compound in the tissue to be assessed.

EXAMPLE 11

In Vivo Imaging Using an Inventive Compound Conjugated to Anti-HER2 Antibody

779 Compound 1-NHS is conjugated to a rabbit anti-HER2 antibody (Genscript USA, Piscataway N.J.) by reconstituting the compound in dimethylformamide (DMF) at 10 mg/ml, then incubating at 10× molar excess with rabbit anti-HER2 antibody (0.1 mg) for one hour at room temperature to result in 779 Compound 1-anti-HER2 conjugate. The conjugation reaction is then subjected to PDDR to remove unlabeled (free) 779 Compound 1. Ten microgram of conjugate is injected intravenously to athymic mice bearing BT474 tumors. The animals are imaged over time at 1, 24, 48, 72, 96, and 120 hours post-injection using Pearl Imager, LI-COR Biosciences (LI-COR Instruments, Lincoln Nebr.).

Upon whole body imaging, fluorescence intensity is observed to be distributed over the whole animal during the first hour imagining and diminishes significantly at 72 hours. After 96 hours, the signal is localized and specific to the tumor.

679 Compound 4/4-NHS is conjugated to a rabbit anti-HER2 antibody (Genscript USA, Piscataway N.J.) by reconstituting the compound in dimethylformamide (DMF) at 10 mg/ml, then incubating at 10× molar excess with rabbit anti-HER2 antibody (0.1 mg) for one hour at room temperature to result in 679 Compound 4/4-anti-HER2 conjugate. The conjugation reaction is then subjected to PDDR to remove unlabeled (free) 679 Compound 4/4. Ten microgram of conjugate is injected intravenously to athymic mice bearing BT474 tumors. The animals are imaged over time at 1, 24, 48, 72, 96, and 120 hours post-injection using Pearl Imager, LI-COR Biosciences (LI-COR Instruments, Lincoln Nebr.).

Upon whole body imaging, fluorescence intensity is observed to be distributed over the whole animal during the first hour imagining and diminishes significantly at 72 hours. After 96 hours, the signal is localized and specific to the tumor.

EXAMPLE 12

In Vivo Imaging Using Either Monosulfonated or Disulfonated Inventive Compound

The compound may be rendered less hydrophilic, i.e., more hydrophobic, by altering the number of sulfonate groups. The fewer sulfonates, the more hydrophobic the compound becomes. In this embodiment, the compound may be more readily retained in a desired tissue or location if the appropriate number of sulfonates is determined; e.g., compound penetration into cells is more efficient if fewer sulfonates are present on the molecule. The compound may contain one, two, three, or four sulfonate groups. Hydrophobic compounds are also known to more efficiently cross the cell membrane, and thus are more desirable when the target of interest is located within the cell.

Alendronate, a compound that binds to, and is retained in, LNCap prostate cancer cells, is conjugated with disulfonated or monosulfonated benzo 779 Compound 1 by incubating a solution containing 1 mM disulfonated or monosulfonated 779 Compound 1-NHS in 1 ml of PBS and 0.5 ml tetrahydrofuran (THF) with 0.1 mM alendronate and 0.2 mM diisopropylethylamine at room temperature overnight. The conjugate is purified using reverse phase HPLC with 0-50% methanol against a 0.1 M ammonium acetate buffer, and is then lyophilized.

LNCap cells are grown orthotopically in nude mice. 779 Compound 1-alendronate (5 nmole) is injected into the tumor. Control mice are injected with free 779 Compound 1 containing a carboxylic acid residue instead of the reactive NHS ester. X-ray and near infra-red fluorescence images are captured.

Upon imaging the whole mouse, 779 Compound 1-alendroneate conjugate is retained in mouse tissue greater than the unconjugated compound; the conjugate is retained in the LNCap cell-induced tumor for at least 18 hrs.

Alendronate, a compound that binds to, and is retained in, LNCap prostate cancer cells, is conjugated with disulfonated or monosulfonated 679 Compound 4/4 by incubating a solution containing 1 mM disulfonated or monosulfonated 679 Compound 4/4-NHS in 1 ml of PBS and 0.5 ml tetrahydrofuran (THF) with 0.1 mM alendronate and 0.2 mM diisopropylethylamine at room temperature overnight. The conjugate is purified using reverse phase HPLC with 0-50% methanol against a 0.1 M ammonium acetate buffer, and is then lyophilized.

LNCap cells are grown orthotopically in nude mice. 679 Compound 4/4-alendronate (5 nmole) is injected into the tumor. Control mice are injected with free 679 Compound 4/4 containing a carboxylic acid residue instead of the reactive NHS ester. X-ray and near infra-red fluorescence images are captured.

Upon imaging the whole mouse, 679 Compound 4/4-alendroneate conjugate is retained in mouse tissue greater than the unconjugated compound; the conjugate is retained in the LNCap cell-induced tumor for at least 18 hrs.

EXAMPLE 13

In Vivo Imaging Using Either Monosulfonated or Disulfonated Inventive Compound

A drug delivery nanoparticle system conjugated with disulfonated or monosulfonated 779 Compound 1 is prepared as follows. A solution containing 1 mM disulfonated or monosulfonated 779 Compound 1-NHS in 1 ml of PBS is incubated

overnight at room temperature with 0.1 mM of an anti-cancer drug conjugated with transferrin in the form of a nanoparticle. The resulting 779 Compound 1-nanoparticle conjugate is purified by centrifugation and then lyophilized.

The 779 Compound 1 (isomer 1)-nanoparticle conjugate (1 nmole) is injected intravenously into a mouse tail vein. Control mice are injected with free 779 Compound 1 dye. X-ray and near infra-red fluorescence images of mouse brain are captured.

779 Compound 1-nanoparticle conjugate localizes in the mouse brain for greater than about 24 hours after injection. Tumor size progressively decreases after injection of 779 Compound 1-nanoparticle conjugate, compared to 779 Compound 1-nanoparticle without the anti-cancer drug.

A drug delivery nanoparticle system conjugated with disulfonated or monosulfonated 679 Compound 4/4 is prepared as follows. A solution containing 1 mM disulfonated or monosulfonated 679 Compound 4/4-NHS in 1 ml of PBS is incubated overnight at room temperature with 0.1 mM of an anti-cancer drug conjugated with transferrin in the form of a nanoparticle. The resulting 679 Compound 4/4-nanoparticle conjugate is purified by centrifugation and then lyophilized.

The 679 Compound 4/4 (isomer 1)-nanoparticle conjugate (1 nmole) is injected intravenously into a mouse tail vein. Control mice are injected with free 679 Compound 4/4 dye. X-ray and near infra-red fluorescence images of mouse brain are captured.

679 Compound 4/4-nanoparticle conjugate localizes in the mouse brain for greater than about 24 hours after injection. Tumor size progressively decreases after injection of 679 Compound 4/4-nanoparticle conjugate, compared to 679 Compound 4/4-nanoparticle without the anti-cancer drug.

EXAMPLE 14

The mono-sulfonated derivative is on any one of eight possible positions on the 579, 679, or 779 compound, accounting for the stereochemistry around the carbon positions on the rings as well as the non-symmetrical nature of the two ends of each dye. Similarly, the di- and tri-substituted sulfonates can be on multiple possible positions on the inventive compounds.

EXAMPLE 15

The inventive compounds are used for in vivo imaging as described in J. Gastrointest Surg (2008) 12:1938-1950. Briefly, human pancreatic cell lines are maintained in media supplemented with penicillin/streptomycin at 37° C. with 5% CO_2. Mouse anti-CEA antibody and Control Mouse IgG (in PBS with 0.20% sodium azide) are conjugated to V08-15173. The dye is reconstituted at 10 mg/ml in DMF and then added to the antibody at a 10 molar excess. The reaction is carried out for one hour at room temperature. The samples are then dialyzed against 3×2 L of PBS. The cell lines are plated in 96-well plates at 5×10^4 cells per well. After 48 hours culture in appropriate media, the cells are incubated with 1 μg of V08-15173 labeled anti-CEA antibody or V08-15173-labeled control mouse IgG for four hours at 37° C. The cells are then washed three times with PBS and then imaged with an inverted Nikon De-485 microscope and Spot camera RD.

Surgical procedures and intravital imaging are performed with the animals anesthesized by intramuscular injection of 0.02 ml of 50% ketamine, 38% xylazine and 12 acepromazine maleate. Human pancreatic and colorectal cancer cell lines are harvested by trypsinization and washed twice with serum free medium and washed twice with serum-free medium. Cells (1×10^6 in 100 μl of serum-free media) are injected subcutaneously within 30 minutes of harvesting over the right flank in female nu/nu mice between 4-6 weeks of age. Subcutaneous tumors are allowed to grow for 7-14 days until they reached diameter of 1-2 mm prior to the delivery of conjugated antibody. For ASPC-1 implants, the cells are harvested by trypsinization and washed 3× in serum-free media. The cells are resuspended in serum-free media. The cells are resuspended in serum-free media at 5×10^6/ml. A volume of 200 μl of the cell suspension is then injected directly into the peritoneal cavity within 30 minutes of harvesting.

For antibody delivery, one to two weeks after subcutaneous, orthotopic, or intraperitoneal tumor implantation, animals are given intravenous (i.v.) injection of either conjugated anti-CEA or conjugated control IgG antibody diluted in PBS to a final volume of 100 μl. All i.v. injections are done via the tail vein. For the dose-response experiment, the antibody dose is 75 μg. For the in vivo time course, the animals are anesthesized and imaged at 30 min, 1, 2, 6, 24 hours and 8 and 15 days after systemic antibody delivery.

Predicted in vivo and ex vivo analysis results are that post-experiment surgical exposure reveals accumulation of dye in the liver, bladder, and a region of inflammation in the subcutaneous tissue. Ex vivo analysis of the vital organs confirms the presence of dye predominantly in the liver with some signal detected in the spleen intestines and lungs.

EXAMPLE 16

The inventive compounds are used for in vivo imaging as described in J. Gastrointest Surg (2008) 12:1938-1950. Briefly, human pancreatic cell lines are maintained in media supplemented with penicillin/streptomycin at 37° C. with 5% CO_2. Mouse anti-CEA antibody and Control Mouse IgG (in PBS with 0.20% sodium azide) are conjugated to 779 Compound 1. The dye is reconstituted at 10 mg/ml in DMF and then added to the antibody at a 10 molar excess. The reaction is carried out for one hour at room temperature. The samples are then dialyzed against 3×2 L of PBS. The cell lines are plated in 96-well plates at 5×10^4 cells per well. After 48 hours culture in appropriate media, the cells are incubated with 1 μg of V08-15173 labeled anti-CEA antibody or V08-15173-labeled control mouse IgG for four hours at 37° C. The cells are then washed three times with PBS and then imaged with an inverted Nikon De-485 microscope and Spot camera RD.

Surgical procedures and intravital imaging are performed with the animals anesthesized by intramuscular injection of 0.02 ml of 50% ketamine, 38% xylazine and 12 acepromazine maleate. Human pancreatic and colorectal cancer cell lines are harvested by trypsinization and washed twice with serum free medium and washed twice with serum-free medium. Cells (1×10^6 in 100 μl of serum-free media) are injected subcutaneously within 30 minutes of harvesting over the right flank in female nu/nu mice between 4-6 weeks of age. Subcutaneous tumors are allowed to grow for 7-14 days until they reached diameter of 1-2 mm prior to the delivery of conjugated antibody. For ASPC-1 implants, the cells are harvested by trypsinization and washed 3× in serum-free media. The cells are resuspended in serum-free media. The cells are resuspended in serum-free media at 5×10^6/ml. A volume of 200 μl of the cell suspension is then injected directly into the peritoneal cavity within 30 minutes of harvesting.

For antibody delivery, one to two weeks after subcutaneous, orthotopic or intraperitoneal tumor implantation, animals are given intravenous (i.v.) injection of either conjugated anti-CEA or conjugated control IgG antibody diluted in PBS to a final volume of 100 μl. All i.v. injections are done by tail

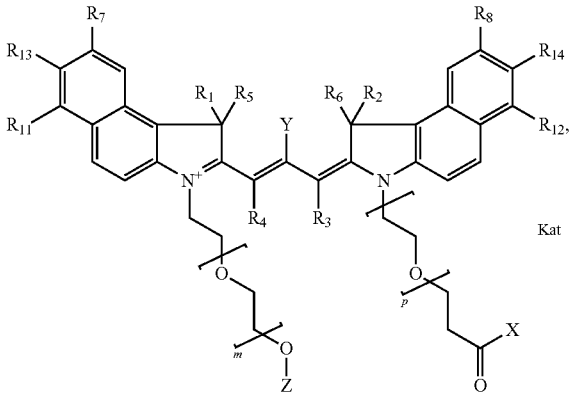
vein. For the dose-response experiment, the antibody dose is 75 μg. For the in vivo time course, the animals are anesthesized and imaged at 30 min, 1, 2, 6, 24 hours and 8 and 15 days after systemic antibody delivery.

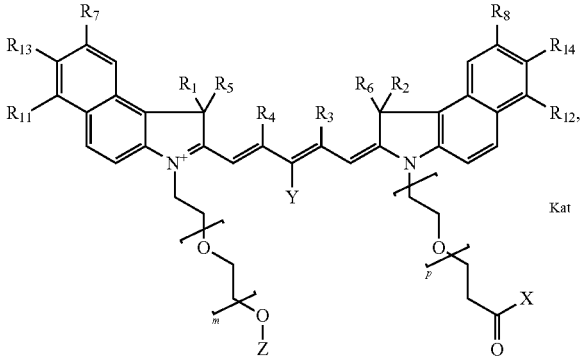
Predicted in vivo and ex vivo analysis results are that post-experiment surgical exposure reveals accumulation of dye in the liver, bladder, and a region of inflammation in the subcutaneous tissue. Ex vivo analysis of the vital organs confirms the presence of dye predominantly in the liver with some signal detected in the spleen intestines and lungs.

The embodiments shown and described in the specification are only specific embodiments of inventors who are skilled in the art and are not limiting in any way. Therefore, various changes, modifications, or alterations to those embodiments may be made without departing from the spirit of the invention or the scope of the following claims. The references cited are expressly incorporated by reference herein in their entirety.

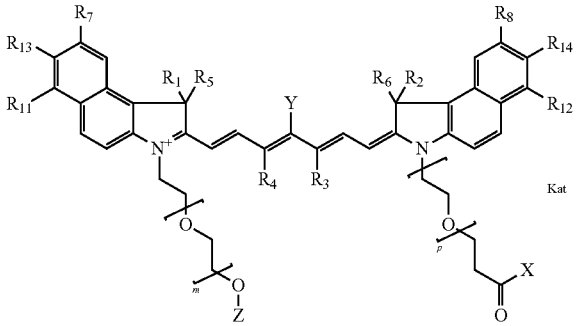
What is claimed is:

1. A compound selected from the group consisting of





and



where

each of R^1, R^2, R^5, and R^6 is the same or different and is independently selected from the group consisting of an aliphatic, heteroaliphatic, sulfoalkyl, heteroaliphatic with terminal SO_3, a PEG group P—Z where P is selected from an ethylene glycol group, a diethylene glycol group, and a polyethylene glycol group, where the polyethylene glycol group is $(CH_2CH_2O)_s$, where s is an integer from 3-6 inclusive, a sulfonamide group -L-SO_2NH—P—Z, and a carboxamide group -L-CONH—P—Z, where Z is selected from H, CH_3, a CH_3 group, an alkyl group, or a heteroalkyl group;

each of R^7, R^8, R^{11}, R^{12}, R^{13}, and R^{14} is the same or different and is independently selected from the group consisting of H, SO_3, a PEG group P—Z where P is selected from an ethylene glycol group, a diethylene glycol group, and a polyethylene glycol group, where the polyethylene glycol group is $(CH_2CH_2O)_s$, where s is an integer from 3-6 inclusive, a sulfonamide-containing group -L-SO_2NH—P—Z, and a carboxamide-containing group -L-CONH—P—Z, where Z is selected from H, CH_3, a CH_3 group, an alkyl group, or a heteroalkyl group;

X is selected from —OH, —SH, —NH_2, —NH—NH_2, —F, —Cl, —Br, —I, —NHS (hydroxysuccinimidyl/sulfosuccinimidyl), —O-TFP (2,3,5,6-tetrafluorophenoxy), —O-STP (4-sulfo-2,3,5,6-tetrafluorophenoxy), —O-benzotriazole, -benzotriazole, imidazole, azide, —O-carbodiimide, —NR-L-OH, —NR-L-O-phosphoramidite, —NR-L-SH, —NR-L-NH_2, —NR-L-NH—NH_2, —NR-L-CO_2H, —NR-L-CO—NHS, —NR-L-CO-STP, —NR-L-CO-TFP, —NR-L-CO-benzotriazole, —NR-L-CHO, —NR-L-maleimide, —NR-L-NH—CO—CH_2—I, or —NR-L-NH—CO—CH_2—Br wherein R is —H or an aliphatic or heteroaliphatic group;

L is selected from a divalent linear (—$(CH_2)_t$—, t=0 to 15), crossed, or cyclic alkyl group optionally substituted by at least one oxygen atom and/or sulfur atom;

Kat is a number of Na^+, K^+, Ca^{2+}, ammonia, or other cation(s) needed to compensate the negative charge brought by the cyanine; m is an integer from 0 to 5 inclusive; p is an integer from 1 to 6 inclusive;

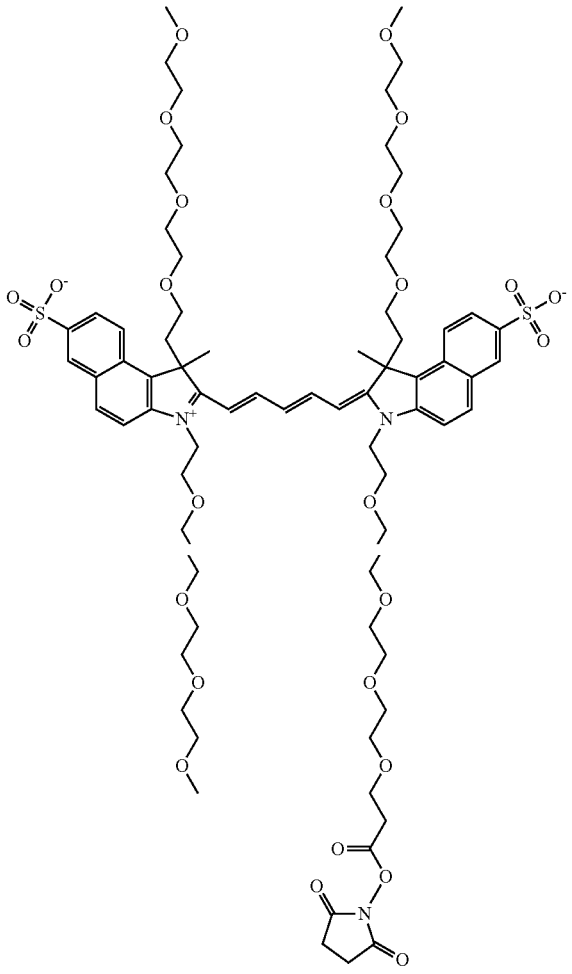
each of R3 and R4 is the same or different and is independently hydrogen, an aliphatic group, a heteroaliphatic group, or a PEG group P—Z where P is selected from an ethylene glycol group, a diethylene glycol group, and a polyethylene glycol group, where the polyethylene glycol group is $(CH_2CH_2O)_s$, where s is an integer from 3-6 inclusive, and Z is selected from H, a CH_3 group, an alkyl group, or a heteroalkyl group; or R3 and R4 together form a cyclic structure where R3 and R4 are joined using a divalent structural element selected from the group consisting of —$(CH_2)_q$—, —$(CH_2)_q$ $O(CH_2)_{q'}$—, —$(CH_2)_q S(CH_2)_{q'}$—, —$(CH_2)_q$CH=CH—, —OCH=CH— where each of q and q' is the same or different and is a integer from 2 to 6 inclusive; and

Y is selected from the group consisting of hydrogen, alkyl, sulfoalkyl, fluorine, chlorine, bromine, a substituted or unsubstituted aryl-, phenoxy-, phenylmercapto function, and a PEG group P—Z where P is selected from an ethylene glycol group, a diethylene glycol group, and a polyethylene glycol group, where the polyethylene glycol group is $(CH_2CH_2O)_s$, where s is an integer from 3-6 inclusive, and Z is selected from H, a CH_3 group, an alkyl group, or a heteroalkyl group.

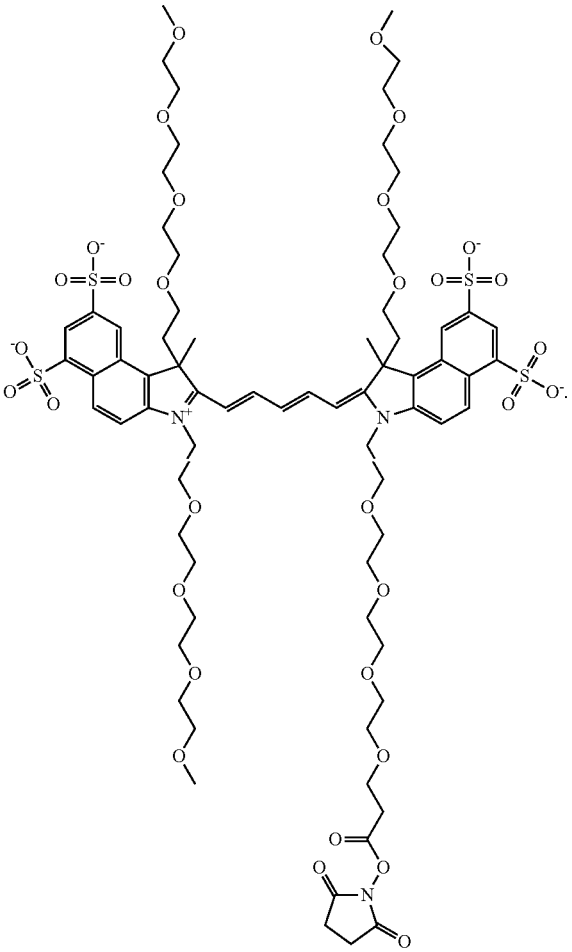
2. The compound of claim 1 wherein each of R13 and R14 is sulfo.

3. The compound of claim 1 wherein each of R7, R8, R11, and R12 is sulfo.

4. A compound selected from the group consisting of compound V10-04152



and compound V08-15173



5. A kit for detecting at least one biomolecule in a sample, the kit comprising the compound of claim 1 and at least one excipient, and instructions for use of the compound to detect a biomolecule in a sample.

6. The kit of claim 5 wherein the compound is V10-04152 or V08-15173.

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